DOCUMENT RESUME

ED 066 871 EM 010 131

AUTHOR	Johnson, Leland L.
TITLE	Cable Communications in the Dayton Miami Valley: Summary Report.
INSTITUTION	Rand Corp., Santa Monica, Calif.
SPONS AGENCY	Charles F. Kettering Foundation, Dayton, Ohio.; Ford Foundation, New York, N.Y.
REPORT NO	R-942 KF/FF
PUB DATE	Jan 72
NOTE	56p.
AVAILABLE FROM	Communications Department, The Rand Corporation, 1700 Main Street, Santa Monica, California 90406
EDRS PRICE	MF-$0.65 HC-$3.29
DESCRIPTORS	*Cable Television; Community Antennas; Computers; Costs; Facsimile Communication Systems; *Feasibility Studies; Home Instruction; Home Programs; *Information Systems; Media Technology; *On Line Systems; Telecommunication
IDENTIFIERS	Broadband Cable Communication; Dayton Miami Valley; Wired City

ABSTRACT

The report summarizes a ten-part study of prospects for cable television (CATV) in the 13 communities that make up the metropolitan area of Dayton, Ohio. The report, written in non-technical language, deals with the economics and technology of CATV, the range of new services that might be provided via CATV, and questions of franchising and ownership of CATV systems. On the basis of these considerations and a ten-year financial projection, the report recommends construction of an interconnected network of six cable systems. The basic system consists of a dual cable plant providing about 40 video channels from the headend to subscriber locations, plus two or three video channels in the reverse direction to permit remote program originations and to provide capacity to handle facsimile mail, data storage and retrieval, viewer interrogation and response, and other services that may be perfected within 5-10 years. For the large number of "general" viewers the report recommends access to ten channels on each of the two cables. For "special interest" viewers another 20 channels would be provided via set-top converters. (MG/Author)

ED 066871

CABLE COMMUNICATIONS IN THE DAYTON MIAMI VALLEY: SUMMARY REPORT

Leland L. Johnson, Study Director

R-942 KF/FF
January 1972

Prepared with financial support from the Charles F. Kettering and Ford Foundations [1]

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OTHER RAND REPORTS ON CABLE TELEVISION

This is one of a series of publications in Rand's Communications Policy Program. Previous reports include:

Leland L. Johnson, *The Future of Cable Television: Some Problems of Federal Regulation*, RM-6199-FF, January 1970.

Herbert Goldhamer (ed.), *The Social Effects of Communication Technology*, R-486-RSF, May 1970.

Richard A. Posner, *Cable Television: The Problem of Local Monopoly*, RM-6309-FF, May 1970.

N. E. Feldman, *Cable Television: Opportunities and Problems in Local Program Origination*, R-570-FF, September 1970.

Rolla Edward Park, *Potential Impact of Cable Growth on Television Broadcasting*, R-587-FF, October 1970.

Leland L. Johnson, *Cable Television and the Question of Protecting Local Broadcasting*, R-595-MF, October 1970.

Rolla Edward Park, *Cable Television and UHF Broadcasting*, R-689-MF, January 1971.

Leland L. Johnson, *Cable Television and Higher Education: Two Contrasting Experiences*, R-828-MF, September 1971.

Michael R. Mitchell, *State Regulation of Cable Television*, R-783-MF, October 1971.

Rolla Edward Park, *Prospects for Cable in the 100 Largest Television Markets*, R-875-MF, October 1971.

Walter S. Baer, *Interactive Television: Prospects for Two-Way Services on Cable*, R-888-MF, November 1971.

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R-942 KF/FF
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PREFACE

In the Dayton-Miami Valley region, as elsewhere in the country, local governments have been under strong pressure to franchise particular cable operators. Recognizing the great potential importance of broadband cable communications to the public, many officials are troubled by the lack of information and guidance required for wise decisionmaking in this new and complex area. What channel capacity should the cable operator be required or encouraged to provide, and for what purposes? How should fees to subscribers and to leasees of channels be established and controlled? What particular local needs can be satisfied by cable? What are the advantages of collective action among municipalities over each city acting independently? More generally, how can flexibility be maintained to take full advantage of opportunities for technological advance and new services in the future?

These are only a few of the questions that have concerned officials in the Miami Valley, as well as in other parts of the country. For this reason the Miami Valley Council of Governments, drawing its membership from 14 cities and villages in Montgomery and Greene counties, has taken the unprecedented action of agreeing to a voluntary moratorium on franchising to await the results of the present study. Till now, cities in other parts of the country have franchised cable operators in response to immediate opportunities and pressures. Those that have postponed making decisions have done so independently, with little or no coordination with other jurisdictions.

This moratorium by the Council of Governments has provided a unique and challenging opportunity to examine (a) the technology and economics of a variety of cable systems, (b) the advantages and disadvantages of a single metropolitan or regional system, (c) the needs in a specific environment, and (d) a host of policy issues relating to the franchising, ownership and control of cable systems.

The purpose of this report is to summarize and to supplement a companion *Basic Report* containing papers that discuss in substantial detail the numerous and complex elements in the development of broadband cable communications.[1] Although these two reports are directed to the particular characteristics of the Miami

[1] *Cable Communications in the Dayton Miami Valley: Basic Report*, R-943-FF/KF, January 1972; hereafter referenced as the *Basic Report*.

Valley region, the analytic approach and the policy conclusions are relevant in many respects to other communities faced with the pressures of franchising and very much in need of help and guidance.

SUMMARY

This report summarizes and supplements the detailed discussions contained in the companion *Basic Report*. It is concerned primarily with the economics and technology of cable, the range of new services that might be provided in the foreseeable future, and questions of franchising and ownership of cable systems. On the basis of ten-year financial projections, it concludes that an interconnected network of six cable systems covering 13 incorporated cities in the Dayton metropolitan area has good prospects for being economically viable. If the unincorporated areas in the metropolitan area can be included to further exploit economies of scale, the economic prospects are enhanced. In contrast, if each city attempts to construct a separate advanced cable system confined to its own boundaries, only Dayton and Kettering are promising candidates.

The basic system postulated for the metropolitan area consists of a dual cable plant providing about 40 video channels from the headend to subscriber locations plus a substantial capacity in the reverse direction equivalent to two or three video channels to permit program origination in remote locations and to provide future capacity to handle facsimile mail, data information storage and retrieval, viewer interrogation and response, and other services that may be perfected over the next five or ten years. For the large numbers of "general" residential subscribers, a simple "A-B" switch would be provided to permit selection from among 20 channels (ten on each cable), without imposing on these viewers the substantial cost of set-top converters. For the smaller number of "special interest" users, about 20 additional channels would be provided with the set-top converter for such things as instruction for elementary, secondary, and higher education, and services for government agencies, business groups, and various professions such as information for medical groups.

This report discusses a few of the many possibilities for using cable: local program origination to meet community needs, adult and higher education; applications in elementary and secondary schools; facsimile mail; information storage and retrieval; interconnected municipal alarm systems and traffic control; and special pay channels for movies, sports, and cultural events not otherwise available on television. Special pay channels may be particularly important in improving the

economic prospects of cable and in providing sources of revenues that would benefit ordinary home subscribers through reduced monthly subscriber fees.

With respect to issues of franchising, some of the major considerations are: A franchise duration of ten years seems most appropriate. Nonexclusive franchises are superior to exclusive ones. The problem of serving low-income areas is not as severe as is commonly supposed because of higher population densities that reduce the cost of cabling individual dwellings. The Council of Governments should consider requiring the cable operator to perform as a common carrier—himself having no control over the content of particular channels, but standing ready to offer channels for lease in accordance with published rates for access to any and all users. Separate ownership of the cable districts serving the metropolitan area has advantages over single ownership in (a) providing yardsticks by which individual cable operators can be judged, (b) reducing the investment requirements of each cable operator, and (c) expediting construction. On the other hand, common ownership of the metropolitan system would avoid the problems of (a) dividing the more profitable and less profitable portions of the area among competing applicants, (b) maintaining compatible system design standards, and (c) sharing costs of jointly used facilities such as studios.

The report concludes by discussing three ownership alternatives: conventional private ownership, government ownership, and community non-profit ownership. Conventional private ownership would be simplest insofar as it is the form in which the industry has evolved to date, and our financial projections suggest that the system would be attractive to private investors. Government ownership, or at least some government financing, would be advantageous in reducing the cost of capital for funding such a large enterprise, and permit growth of cable into more sparsely populated areas. Nonprofit community ownership would be difficult to organize, but if successful it might provide (a) a valuable yardstick against which to judge performance of cable systems under contrasting ownership arrangements elsewhere in the country; (b) more direct responsiveness to public policy considerations, such as hiring from minority groups, and (c) direct application of system profits to public uses.

ACKNOWLEDGMENTS

Within a short space it would be quite impossible to express our deep gratitude separately to the dozens of individuals and groups in the Miami Valley who have interacted with us in supplying data, answering questions, and making useful suggestions and criticisms during the course of the study. Here we will mention only a few who have played key roles throughout the course of the study.

Dr. Wayne Howell of The Kettering Foundation made innumerable useful suggestions for structuring the study and spent countless hours organizing and working with a number of local committees that met periodically with the Rand team. Mrs. Bonnie Macaulay, Chairman of the Miami Valley Council of Governments Committee on CATV and Vice Mayor of Oakwood, raised key questions of concern to the CATV committee that have helped to shape the nature of the final report. Dr. Jeptha Carrell, Executive Director, and William Schneider, Research Associate, of Community Research, Inc., suggested to us numerous useful personal contacts within the community, and provided many helpful comments during the course of the study. Charles Lewis, member of the Montgomery County Board of Commissioners and President of MVCOG made a number of penetrating comments and suggestions during our formal briefings and offered warm encouragement at every step of the way. Winston Franklin of The Kettering Foundation undertook very well the responsibility for organizing and initiating the study in accordance with the needs of MVCOG. Paul Ziehler, Executive Secretary of MVCOG, provided data and assistance frequently on a rush basis, during crucial points in the effort. William Lehman, Television Coordinator at Wright State University offered many useful comments and data on instructional uses of television, particularly in higher education. The Miami Valley Regional Planning Commission, through its Director Dale Bertsch and his staff, supplied data on population projections and other growth characteristics of central importance in cable system design. The Transportation and Development Planning Program, Montgomery and Greene Counties, through its Coordinator Carl Doppes and his staff, made available detailed maps, street configurations and other material also of central importance.

In addition to our gratitude to The Charles F. Kettering Foundation and to The Ford Foundation for their support of this project, we wish to express our apprecia-

tion to The John and Mary R. Markle Foundation for a three-year grant in July 1970 to Rand's Communications Policy Program. This sustained financial support has been indispensable in enabling us to undertake basic research and analysis in cable technology, economics, and public policy required to assess specific problems and to respond in a timely way to specific needs—of which this study is one example.

THE PARTICIPATION OF LOCAL COMMITTEES

This is an unusual project in that it was undertaken with extensive participation by members of the local community. In July, September, and November 1971, a number of local committees were briefed about the progress of the work, and long discussions were held with them about their reactions, suggestions, and criticisms. Although these committees are not to be held responsible for the final product, their many valuable inputs have greatly improved the quality of the work. These committees and their chairmen include:

- Citizens Advisory Committee on Religion, Dr. Aaron Scheaffer, Director, Seminary Relations, United Theological Seminary
- Civic-Government Committee, Charles Horn, Mayor, City of Kettering
- Community Development Committee, Joseph Orndorff, Director of Community Services, Dayton-Miami Valley Consortium of Colleges and Universities
- Cultural and Leisure Committee, Eugene Bohlander, Resident Partner, MacDonald and Company
- Education Committee, Carl Beers, Supervisor of Mathematics and Summer School, Dayton Board of Education
- Legal and Finance Committee, Frank Anger, Former Chairman of the Board, Winters National Bank
- Medical Committee, W. J. Lewis, M.D., President of the Combined Montgomery County Board of Health
- Medical Education Committee, Elvin Hedrick, M.D., Director, Medical Education, Kettering Medical Center
- Public Health Committee, Stephen Davie, Health and Welfare Planning Council
- Student-Teacher Committee, Ronald Price, Faculty, Oakwood High School
- Technical-Engineering Committee, Carl Rench, Vice President, Engineering and Research, National Cash Register Company

To the members of these committees and to their chairmen we express our deep appreciation for the many hours they spent with us in thinking through the hard problems and questions relating to the new, complex, and exciting field of cable communications.

LIST OF PAPERS IN THE COMPANION BASIC REPORT

These ten papers are referenced in footnotes throughout the discussion in this Summary Report.

1. SYSTEM DESIGNS FOR THE DAYTON METROPOLITAN AREA, Nathaniel E. Feldman
2. FINANCIAL PROJECTIONS FOR THE DAYTON METROPOLITAN AREA, Walter S. Baer and Rolla Edward Park
3. COVERAGE OF THE FIVE-COUNTY MIAMI VALLEY REGION, Nathaniel E. Feldman
4. CABLE SYSTEMS AND THE SOCIAL GEOGRAPHY OF DAYTON, Robert K. Yin
5. CABLE TELEVISION AND PUBLIC INTEREST PROGRAMS, Robert K. Yin
6. TELEVISION AND THE DAYTON-AREA RESIDENT: THE RESULTS OF A PUBLIC OPINION SURVEY, Robert K. Yin
7. THE POTENTIAL USES OF CABLE IN EDUCATION AND TRAINING, Rudy Bretz
8. THE APPLICATION OF CABLE TO CONTINUING MEDICAL EDUCATION, Rudy Bretz
9. ISSUES OF FRANCHISING, Leland L. Johnson
10. OWNERSHIP ALTERNATIVES, Walter S. Baer and D. H. Camph

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I. INTRODUCTION

The promise of broadband cable communications has aroused widespread interest. In addition to offering improved reception of signals from broadcasting stations, its large channel capacity permits many other types of programming aimed at specialized small audiences economically infeasible to serve through conventional broadcast. Vocational education in the home, external degree programs, classroom use, and special local community programming immediately come to mind. Moreover, with future development of two-way communications on cable, a host of other services may become economically and technically feasible. Table 1 lists many potential two-way interactive services that have been discussed in the past.

In contrast to this exciting potential, the cable industry today operates essentially as a master antenna service or community antenna television service (hence, the frequently used initials CATV). As illustrated in Figure 1, a typical system consists of a antenna on a high tower in some favorable location, frequently on a hilltop, where signals can be picked up over the air and sent to a "headend." The headend—a building containing signal processing and other equipment represented by the rectangular housing in Figure 1—is a central point from which signals are fed into coaxial cable distribution lines strung along existing telephone or electric power poles to connect residential and other subscribers. Because this service can provide subscribers with improved reception of local broadcasting stations and, in many cases, also carry signals of more distant broadcast stations otherwise unavailable, many television viewers are willing to pay the $5.00 or so per month, plus an installation fee of $15.00-$20.00 for the service.[1]

Based on the retransmission of local and distant broadcasting signals, the industry has grown rapidly. At the beginning of 1971 it encompassed nearly 2600 systems serving 5.3 million subscribers. This growth is shown over a 20-year period in Table 2. Most of these systems are located in small communities lacking local broadcasting stations or located where broadcast reception is poor. Growth in major metropolitan areas has been slow because they have a number of local broadcasting stations

[1] The signals from distant stations can be picked up off the air if the master antenna is tall enough and favorably enough located, or signals can be brought in by microwave links directly to the master antenna tower or to the headend.

Table 1

SOME PROPOSED INTERACTIVE SERVICES FOR CABLE TELEVISION[a]

Services for Individuals	*Services for Business*	*Services for Government*
Interactive instructional programs	Television ratings	Computer data exchange
Fire and burglar alarm monitoring	Utility meter readings	Teleconferencing
Interactive TV games	Control of utility services	Surveillance of public areas
Quiz shows	Opinion polling	Fire detection
Subscription television	Market research surveys	Pollution monitoring
Remote shopping	Computer data exchange	Traffic control
Special interest group conversations	Business transactions	Fingerprint and photograph identification
Electronic mail delivery	Credit checks	Civil defense communications
Electronic delivery of newspapers and periodicals	Signature and photo identification	Area transmitters/receivers for mobile radio
Computer time sharing	Facsimile services	Classroom instructional television
Videophone	Report distribution	Education extension classes
Catalog displays	Industrial security	Televising municipal meetings and hearings
Stock market quotations	Production monitoring	Direct response on local issues
Transportation schedules	Industrial training	Automatic vehicle identification
Reservation services	Teleconferencing	Community relations programming
Ticket sales	Corporate news ticker	Safety programs
Banking services		Various information retrieval services
Inquiries from various directories		Education for the handicapped
Local auction sales and swap shops		Drug and alcohol abuse programs
Direct opinion response on local issues		
Electronic voting		
Subscriber originated programming		
Interactive vocational counseling		
Local ombudsman		
Employment, health care, housing, welfare, and other social service information		
Library reference and other information retrieval services		
Dial-up video and audio libraries		

SOURCE: Walter S. Baer, *Interactive Television: Prospects for Two-Way Services on Cable*, The Rand Corporation, R-888-MF, November 1971, p. 4.

[a]These services are not all likely to be economically feasible on cable television networks. Some may not even be socially desirable. They have been compiled from various reports, FCC filings, corporate brochures, and advertising materials.

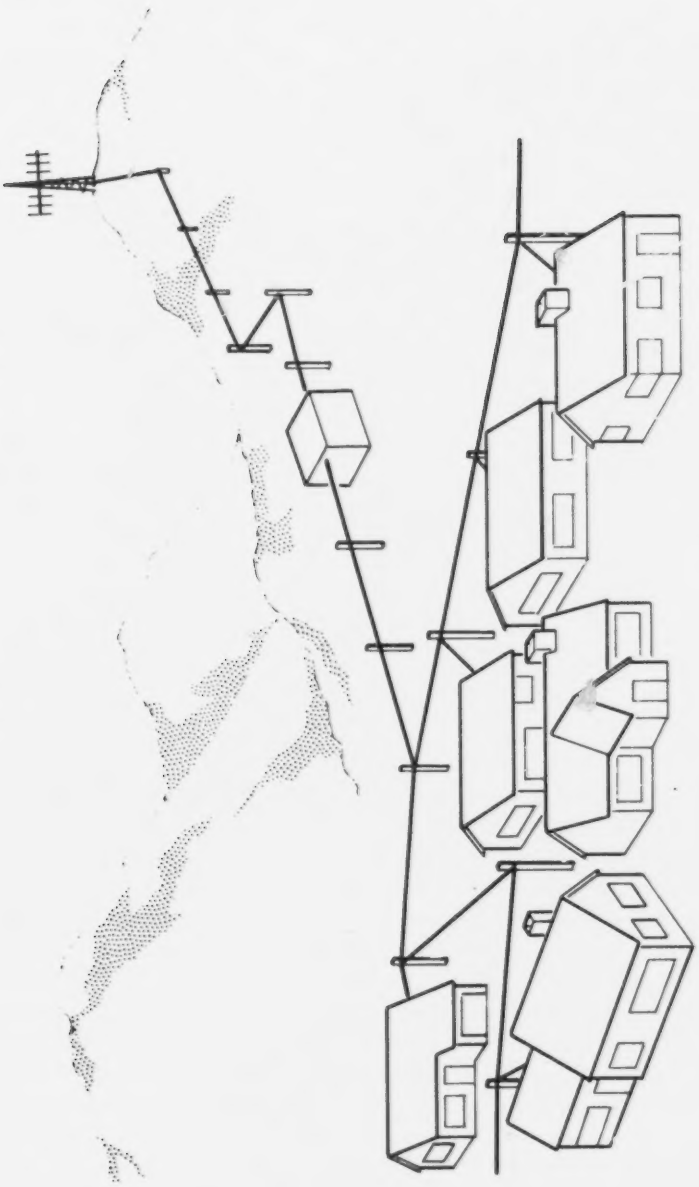


Fig. 1—Conventional one-way cable system serving residential subscribers

Table 2

GROWTH OF CABLE TELEVISION

Year	*Operating Systems*	*Total Subscribers*
1952	70	14,000
1953	150	30,000
1954	300	65,000
1955	400	150,000
1956	450	300,000
1957	500	350,000
1958	525	450,000
1959	560	550,000
1960	640	650,000
1961	700	725,000
1962	800	850,000
1963	1,000	950,000
1964	1,200	1,085,000
1965	1,325	1,275,000
1966	1,570	1,575,000
1967	1,770	2,100,000
1968	2,000	2,800,000
1969	2,260	3,600,000
1970	2,490	4,500,000
1971	2,570	5,300,000

SOURCE: *TV Factbook*, Services Volume, 1971-72 Edition, p. 81-a.

offering good reception, and because since 1966 the Federal Communications Commission has prohibited the retransmission of signals from distant broadcasting stations into major cities. However, at this writing, the FCC is proposing to liberalize its rules to permit the carriage of a limited number of distant signals into major markets—a move designed to enhance the prospects for cable in these areas.[2]

With continuing improvements in cable technology and prospects for more liberal FCC regulatory policy, cable operators have expressed strong interest in moving into the larger cities. Many municipal governments have been under great pressure to grant franchises to particular cable operators, and a number of cities—such as New York, Atlanta, Columbus (Ohio), and Philadelphia—have already signed franchises covering some or all of their jurisdictions. Extensive hearings and discussions

[2] The long debate concerning the FCC's policies toward cable is discussed in other Rand reports. See Leland L. Johnson, *The Future of Cable Television: Some Problems of Federal Regulation*, RM-6199-FF, January 1970; Rolla Edward Park, *Potential Impact of Cable Growth on Television Broadcasting*, R-587-FF, October 1970; *Prospects for Cable in the 100 Largest Television Markets*, R-875-MF, October 1971.

have been held in other cities. Dayton and several neighboring cities and towns have also come under pressure to grant franchises to particular operators.[3]

However, many officials in the Dayton area have felt uneasy about moving ahead on their own. Like most government officials elsewhere, they have had little information to provide a foundation for wise decisionmaking in this new and complex area. Until recently, many had hardly heard of cable, much less had a sound basis for making decisions in the public interest. What channel capacity should the cable operator be required or encouraged to provide and for what purposes? How should rates to subscribers be established and controlled? What are the particular needs of the area that can be satisfied by cable? What are the advantages of a metropolitan or regional system developed in cooperation among all of the municipalities, in comparison with the outcome of each city going its own way in separate franchising? These are merely some of the questions that have troubled officials in the area. For this reason the Miami Valley Council of Governments, representing the governments of cities in Montgomery and Greene Counties, acted through a special CATV committee to request a voluntary moratorium on franchising to await the results of the present study. This moratorium, embracing more than a dozen cities, is unprecedented. Until now, cities in other parts of the country have franchised cable operators in response to immediate opportunities and pressures. Those that have postponed making decisions about cable have done so on a unilateral basis with little or no coordination with other jurisdictions. This moratorium by the Miami Valley Council of Governments has provided a rare and challenging opportunity to examine the technology and economics of a variety of cable systems; to evaluate the advantages and disadvantages of a single metropolitan or regional system; to examine the kinds of needs that cable might satisfy in a specific environment; and to examine a host of policy issues relating to the franchising, ownership, and control of cable systems.

The purpose of this report is to bring together in summary form major points in the individual papers contained in the companion *Basic Report*. This Summary Report is divided into three major parts:

- The technolgy and economics of advanced cable systems.
- Near-term and longer-term services that may be provided on cable in the Dayton-Miami Valley region.
- Policy recommendations, guidelines, and problems regarding the franchising, ownership, and operation of one or more systems in the area.

[3] See, for example, *Dayton Journal Herald*, June 4, 1971, p. 25; October 20, 1971, p. 29; and October 23, 1971, p. 31.

II. THE TECHNOLOGY AND ECONOMICS OF ADVANCED CABLE SYSTEMS

The technology of currently used one-way cable is relatively simple. As television signals are sent along in the cable they lose strength or are attenuated, depending on the diameter of the cable and the distance traveled. They are restored to the necessary levels by a series of amplifiers spaced along the cable at approximately one-third mile intervals. The main trunk cable (with a diameter of about 3/4 inch) runs from the headend along major routes from which smaller diameter feeder cable (less than 1/2 inch) branches off into individual blocks of homes. Smaller diameter drop lines (1/4 inch) run from the feeder to the subscriber's location and are attached to the back of the receiving sets as a substitute for the ordinary lead-in wire from a rooftop antenna. Outlets can be extended from the drop line to serve additional sets in the home. Today, most cable systems carry from 5 to 12 channels of television. Some also carry FM radio signals and others originate local programming such as news, time and weather, and local sports, in addition to merely retransmitting broadcast signals.

More advanced systems now being constructed in some cities have two main characteristics that distinguish them from earlier systems: (a) they provide many more channels, (b) they have a two-way capability to carry returning digital, voice, or perhaps even video signals back to the headend—a capability essential to two-way interactive services of the sort listed in Table 1.

CHANNEL CAPACITY

With respect to the first characteristic—that of more channels—Figure 2 illustrates the frequency range for radio and television broadcast services, running from 3 million cycles per second (or 3 MHz) to 890 MHz. The frequency range currently used for cable transmission runs from about 3 MHz up to about 270 MHz, encompassing both the VHF television broadcast bands and additional bands used for FM radio broadcasting and other services.

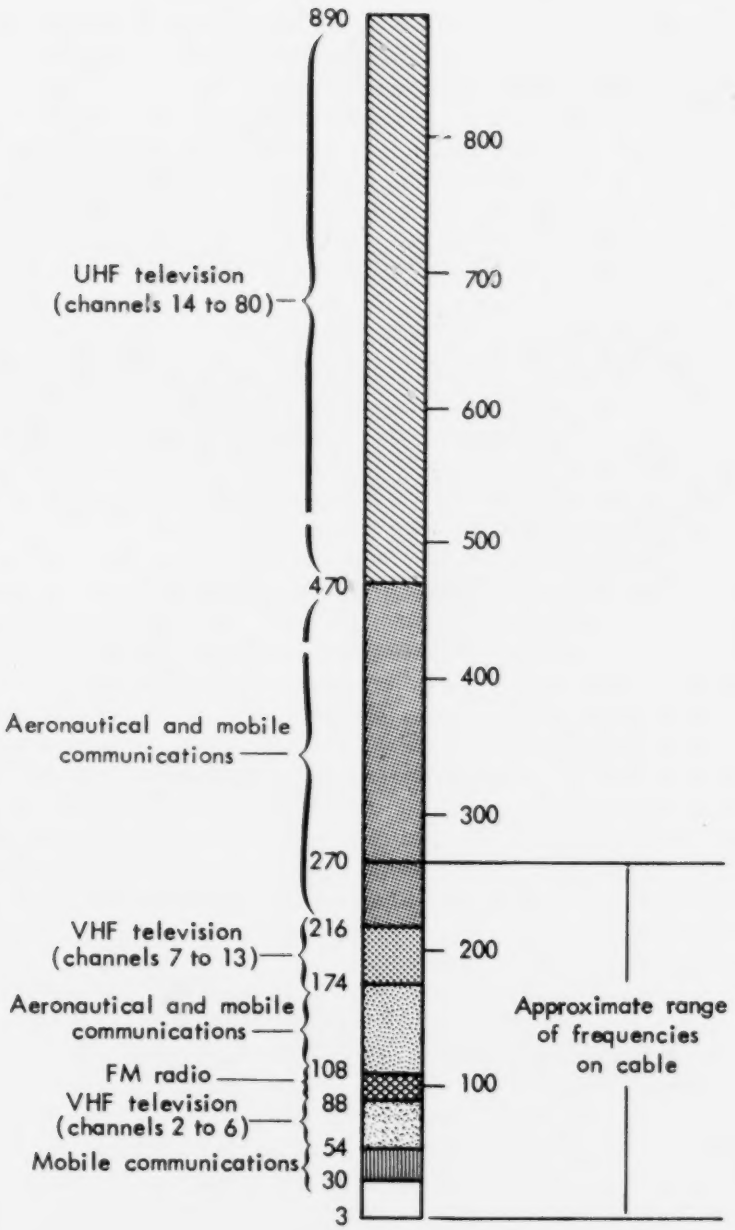


Fig. 2—Range of frequencies in megacycles per second (MHz) for radio and television broadcast

While frequencies above 270 MHz—extending into the UHF range—can be carried on cable, the problem of signal attenuation becomes increasingly severe at higher frequencies. At this stage of cable development the practical limit remains below the UHF range. Since each television channel occupies the bandwidth of 6 MHz, the theoretical capacity of the cable is roughly 45 channels below 270 MHz. However, problems of intermodulation and crosstalk in the amplifiers reduce the feasible capacity to a range of 20-30 channels. The precise number depends on several factors—the number and design of amplifiers spaced along the cable, the standards of reception quality to be met, and the amount of maintenance cost cable operators are willing to bear. Generally, the greater the number of channels employed, the lower the quality of reception because of mounting interference between channels, and the higher are the costs required in adjusting amplifiers and other equipment to maintain a given quality of service. Considering both the cost and performance of the technology likely to be available soon, we conclude that 20-25 channels per cable is the relevant range of choice.[1]

Unfortunately, the constraint on channel capacity is not determined simply by cables and amplifiers. The television receiving set itself is a bottleneck. A standard set receives cable channels only on its 12-channel VHF tuner. (The UHF tuner is useless since, as shown in Figure 2, the frequencies carried on cable lie below the UHF range). Thus, regardless of how many channels the cable carries, capacity of the system is limited to 12 channels for conventional, unmodified sets.

There is yet another complication: the lead-in wire from the back of the set to the VHF tuner is subject to interference from strong over-the-air signals operating at the same frequencies. In the Dayton area, channels 2 and 7, used by local broadcasting stations, would cause interference on the same channels operating on the cable system. Normally, the cable operator would not attempt to use the two channels; rather he would convert at the headend the frequencies of the incoming broadcast signals to other frequencies not subject to interference for carriage on the cable.[2] Thus, in the Dayton area only 10 channels would be available for conventional sets. (In cities where 3 or more VHF stations are located, the problem of interference is that much more severe).

A 10-channel capacity is insufficient in the light of the FCC's proposed rules that require or permit the cable operator to retransmit broadcast signals. Under the proposed rules, the cable operator must carry all local signals. In the Dayton area this would include three network affiliated stations, one non-commercial station soon to go on the air, and one independent UHF station that has been off the air in recent months but, reportedly, is planning to resume broadcasting soon. The rules also would require the cable operator to provide an additional channel for local program origination. They would also require the cable operator to carry the three Cincinnati network affiliated stations and would permit him to import two distant

[1] *Basic Report*, Paper One, pp. 29 Hereafter, references to papers will be to those in the *Basic Report*.

[2] Similarly, at the headend he would convert UHF broadcast signals to lower frequencies corresponding to empty slots on the VHF dial.

independent stations.[3] Moreover, this total of 11 channel slots does not include space for other local stations that might come on air in the Dayton area within the next five to ten years.

There are two main approaches of overcoming the problem of limited channel capacity arising from this bottleneck:

(1) A converter can be installed on the receiver to transform all channel frequencies coming in on the cable to a single frequency corresponding to an empty slot on the VHF dial. In the Dayton area, for example, the cable subscriber might set his VHF dial permanently to Channel 9 (an otherwise empty channel) and then select from the 20 channels or so on the cable by using a tuner knob on the converter. Although a number of cable systems, as in New York City and in Tulsa, are using such converters to increase channel capacity, this approach has at least two disadvantages: (a) it adds to cost since the converters run to about $35 apiece and many cable operators complain that maintenance costs are high with the present state of converter development, (b) the converters contribute to some degradation in quality of reception. Since a major factor in selling cable service is improving reception, this degradation can be a major drawback.

(2) Two cables each with 10 channels can be installed and converted to the receiving set with simple "a-b" switch with which the viewer can select channels from either cable. Thus, he could select a channel on his VHF tuner and switch either to cable "a" or to cable "b" to double his choice in programming. Although dual cable plant is somewhat more expensive than single cable, it obviates the need for a converter. Moreover, at a low additional cost of about 10 percent, each cable can carry 20, or perhaps more, channels.[4] For specialized-interest users willing to purchase converters, the additional channel capacity system provided by dual cable could serve a variety of other needs. Thus, without a converter the ordinary home viewer would have up to 20 channels. With a converter specialized users could have an additional 20 or so. Moreover, specialized users, such as government offices, viewers taking college course work at home, and school districts, would more likely be willing to purchase or lease more expensive converters (in the $50-$100 range), in order to improve picture quality. Because of these factors, a number of cable operators are using dual cable plant, as in Akron, Ohio, and in San Jose, California.

In the Dayton metropolitan area, our ten-year financial projections indicate that dual cable is less costly than single 20-cable with converters in each subscriber location.[5] Since dual cable also has the potential of further increasing capacity to 40 channels with use of converters, dual cable seems clearly the better choice. For these reasons, our analysis from this point will be confined to dual cable design.

The critical aspect in our analysis is that both cables be installed at the same

[3] Letter dated August 5, 1971, from Dean Burch, Chairman, to the Chairmen of the Senate Communications Subcommittee and the House Communications and Power Subcommittee. Today, cable operators are not liable for copyright payments in carrying whichever distant signals they are permitted by the FCC. However, legislation will probably be passed by Congress to accompany the new FCC rules. Provisions for copyright payments are made in our financial projections in Paper Two.

[4] Paper One, pp. 28.

[5] Paper Two, p.6.

time in order to lower the additional cost of adding the second cable (about $2000 per mile additional cost compared with perhaps $5700 per mile for a single cable installed alone).[6] Indeed, even a third cable could be installed at the same time and at about the same additional cost to supply additional capacity to heavy users. This possibility, involving a third cable for use of elementary and secondary schools, and perhaps for hospitals and public agencies along the same route, is discussed in the *Basic Report.*

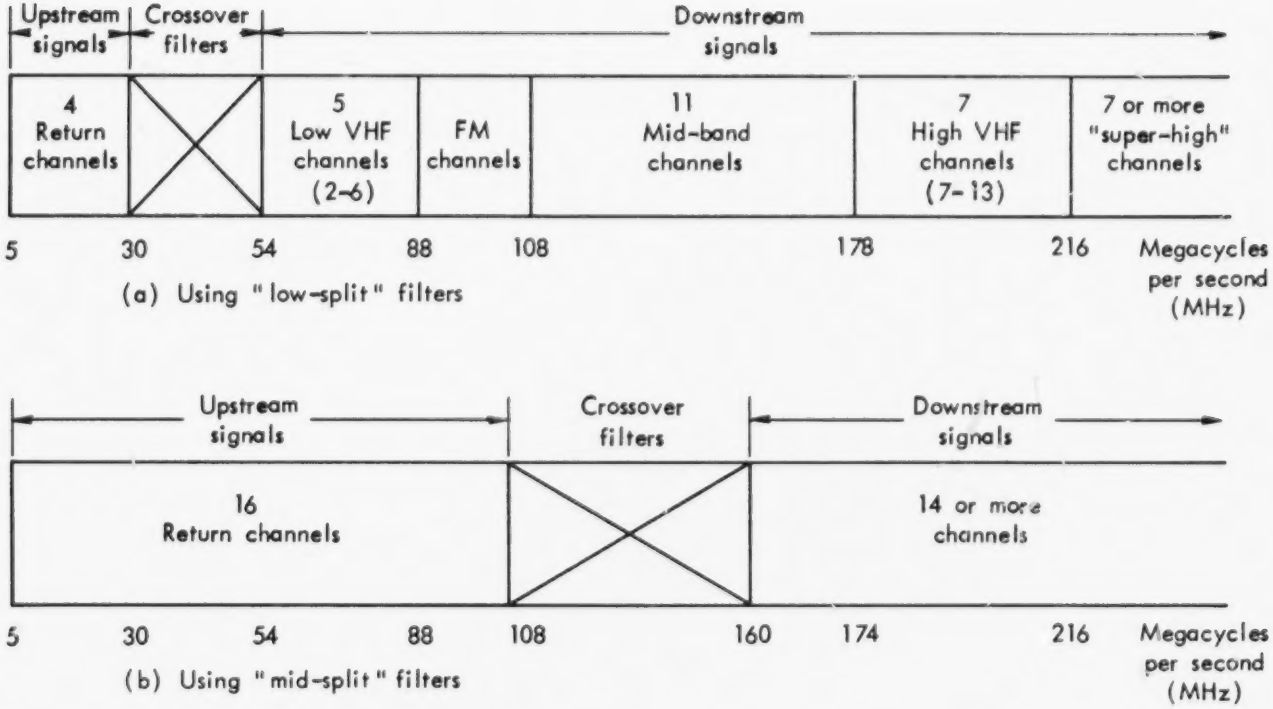
TWO-WAY CAPABILITY

In addition to providing many more channels than can be available through conventional over-the-air broadcasts, cable offers the possibility of two-way transmission. As shown in Figure 3 a cross-over filter can be installed in the amplifiers to separate the forward (or "downstream") channels from the reverse (or "upstream") channels in the same cable. The latter can be used for digital and voice response from special subscriber terminals to provide the kinds of services noted in Table 1. In some cases the capacity may be sufficient to permit origination of television programming at remote points along the cable and sending the signal back to the headend for distribution to other points in the system—a capability that would be required, say, for closed circuit television conferencing.

As shown in Figure 3 the amount of reverse channel capacity depends on whether the cross-over filter is a low-split or high-split. (In both cases the number of channels shown would exceed the practical limit because of cross-talk and intermodulation mentioned previously.) The high-split filter has certain technical advantages over the low-split and also permits greater reverse capacity, but at the expense of reducing the number of forward channels. If two-way mid-split channels are included on one of the two cables, the conventional television set would have only channels 8-13 on that cable (Channel 7 would be blanked out as mentioned earlier, because of interference from a local VHF station). Still, the ten channels on the first cable and six on the two-way cable would probably be sufficient for ordinary viewers who do not wish to incur the cost of converters available to specialized users.

The development of two-way technology is in its infancy. That interference can be satisfactorily prevented between the forward and reverse channels during day-in, day-out operation remains to be demonstrated. Moreover, the subscriber terminals required for two-way operation are only in prototype development, in cases where they exist at all. Yet two-way service has the potential for an exciting range of new

[6] These costs are for overhead or "aerial" installations on existing utility poles. For *new* residential or business areas where cable can be put underground in common ducts with electric and telephone lines the costs would be in the same range. However, for underground installations in *existing* built-up areas where duct space is not available under streets and sidewalks, the cost can run much higher; for example, costs of $100,000 per mile have been encountered in New York City. However, the amount of existing underground construction in the Dayton metropolitan area is very small today. See Paper One. p. 34.



Source: Walter S. Baer, Interactive television, p. 72

Fig. 3—Frequency multiplexing schemes for two-way transmission

and improved services. In response, the FCC is proposing at this writing to require all new cable systems in large cities to include a two-way capability.[8]

NEAR-TERM ECONOMIC PROSPECTS

One of the most important questions in the Rand study relates to the economic prospects for advanced high-capacity cable systems—especially in light of the fact that advanced systems entail higher costs than the traditional form of "CATV." In appraising these prospects, a factor of crucial importance involves the number of viewers willing to pay for conventional cable television service. It is true that cable may eventually be used for many other things, such as facsimile transmission, information storage and retrieval, alarm systems, shopping and so forth. Although such services may eventually contribute substantially, perhaps the lion's share, to the revenue base, their eventual costs and market demand are impossible to predict satisfactorily at this time. It is also true that advertising on cable channels may provide an additional source of revenue; however, it is not clear that advertising revenues will be sufficient by themselves to cover even the costs of additional programming carried on cable channels, let alone helping to offset the cost of the hardware.[9] Over the next few years at least, cable operations will depend heavily on attracting television subscribers in the same manner as in the past—with improved reception and more broadcast signals than are available locally.

On this basis, the prospects for cable growth in Dayton appear good, largely because over-the-air broadcasting in the Dayton area is not as well developed as it is in most other metropolitan areas, and because major modifications expected soon in FCC regulatory policies toward cable may work to the particular benefit of Dayton as a result of its geographical location. These two factors will be discussed in turn.

The Existing Level of Over-the-Air Service

Dayton has two VHF network affiliates and one UHF network affiliate, whereas most other large markets have all three affiliates on the VHF dial. Until recently, Dayton has also had two UHF independent stations, one in nearby Springfield, but both have gone dark in recent months. (According to recent reports, the Springfield independent UHF station, WSWO, may soon return to the air.) Many other cities comparable to Dayton in size—such as Seattle, Portland, and Milwaukee—have at least one UHF or VHF independent station. More generally, within the largest 50 markets, where Dayton ranked 26th in 1970, only 11 others face the same situation

[8] The economics and technology of two-way service are treated in greater detail in Baer, *Interactive Television.*

[9] Our financial projections include only a modest amount—$3 per year per subscriber—for advertising revenues. Paper Two, p. 136.

as Dayton in having a network affiliate on UHF rather than VHF.[10] Of the 50 markets, only 18 (including Dayton) have no independent service. Finally, Dayton has had no public, non-commercial service; 41 of the other top 50 markets do have at least one non-commercial station. Recently the State of Ohio purchased the facilities of one of the UHF independent stations, WKTR, Channel 16, for use as a non-commercial station as part of the state educational television network.

These are important factors in appraising the prospective cable growth in the Dayton area. One advantage of cable is in placing UHF stations on a parity with VHF. UHF stations face a substantial handicap today in using frequencies that have poorer propagation characteristics than VHF and in forcing the viewer to use a separate and rather cumbersome tuner. On this count we would expect the attractiveness of cable to potential subscribers to be greater in Dayton than is true in the more typical case in the largest 50 markets where all three affiliates are on VHF.

Moreover, the lack of one or more strong independent stations to provide additional programming choice in the Dayton area contributes to making it a more attractive cable market than is the case in other cities such as Chicago, Washington, and New York, where several independent stations already provide much of the diversity in programming that only cable makes possible in other parts of the country.[11]

Policies of the Federal Communications Commission

Cable has not grown in the Dayton area, in part because of restrictive FCC regulatory policies with respect to carriage of distant signals.[12] At this writing, were a cable operator in business in Dayton, he would not be permitted to bring in distant signals from Indianapolis or Columbus, nor would he be permitted to bring in signals even from nearby Cincinnati despite the fact that Cincinnati signals can be picked up over the air in the Dayton area. To receive outside signals today, many viewers install a back-yard tower or a rooftop mast with elaborate antenna arrays to pick up Cincinnati's three VHF network affiliates and one independent UHF station.

However, the FCC is proposing to modify its rules to permit cable operators in major cities to carry some outside signals. In the case of Dayton, the three Cincinnati network affiliates could be carried because they are "significantly viewed over the air" in the Dayton area. In addition, three independent signals could be carried—at least two of which could be carried from outside the Dayton market. If the Springfield UHF independent station resumes broadcasting, then in addition to its carriage on cable two additional signals could be brought in from distant markets. (Otherwise, three additional signals could be carried from distant markets). One

[10] The rankings and station availabilities in the various markets are listed in *Television Factbook*, Services Volume, 1970-71, p. 42a.

[11] Two cable systems are operating in New York City, but much of their appeal derives from reception problems of over-the-air broadcasting caused by numerous tall buildings.

[12] A cable system operating in nearby Xenia is bringing in distant signals because it commenced operation before the restrictive FCC rules were established, and its right to import distant signals was "grandfathered" under those rules.

would probably be the independent UHF station, WXIX, Channel 19, in Cincinnati; the other the independent VHF station, WTTV, Channel 4, in Indianapolis.[13]

Estimates of Cable Penetration

To estimate the level of cable penetration in major markets (the percentage of homes passed by cable plant that subscribe to cable service) a previous Rand study by R. E. Park examines a sample of cable systems in various parts of the country where over-the-air broadcasting service is good—comparable in many cases to that available in the Dayton area.[14] Based on that study alone we estimate that approximately 30 percent of the homes in the Dayton metropolitan area would subscribe to cable in accordance with the signal package permitted under the FCC proposed rules, along with whatever other services cable operators *today* typically provide (such as time and weather reports).[15]

However, because of several additional factors, it is reasonable to expect that penetration would exceed the 30 percent figure and rise to perhaps 40 percent within a few years after the system is built—and possibly rise to far greater levels in the more distant future. First, the continued growth of family income would tend to boost penetration. The Park study suggests that the level of penetration is sensitive both to the monthly fees charged for cable service and to the level of family income. Generally speaking, we would expect a 10 percent decrease in the subscriber monthly fee to bring about approximately a 10 percent increase in the level of penetration; also, a 10 percent rise in family income would be expected to bring about a 10 percent increase in penetration. Second, continued growth in the use of color television sets (especially sensitive to quality of reception) would tend to attract additional subscribers. Third, inclusion of new services, especially pay-movie and pay-sports channels, would tend to boost further the level of penetration—both by enhancing the appeal of the cable service package to attract additional subscribers directly, and by adding to lease-channel revenues that would contribute to lower monthly fees for *all* subscribers. Fourth, as discussed in the *Basic Report* a Dayton area system may do better in terms of sales promotion; customer relations and other factors than has the *average* of the systems included in the sample from which the 30 percent estimate was derived.

[13] In a recent agreement among broadcasting, cable, and copyright interests, programs from distant stations can be brought into the larger 50 markets (including Dayton) only if they do not violate the exclusivity provisions under which programming is sold to local stations. Specifically, cable operators would be prohibited from carrying any syndicated material for one year after its first appearance anywhere in the country and then for the life of the contract under which it is sold to a local station by the program syndicator. See *Broadcasting*, November 8, 1971, p. 17. However, this exclusivity protection will likely be a less serious impediment in the Dayton market than in many other major markets, because in Dayton there are no strong independent stations in a position to buy up large blocks of programming for their exclusive use. In markets such as Washington, Chicago, and New York, where several strong independent stations exist, these exclusivity conditions would constitute more serious barriers to importation of distant signals.

[14] Park, *Prospects for Cable in the 100 Largest Television Markets.*

[15] Paper Two, Addendum 2-A.

Using the 40 percent estimated penetration at a basic $6 monthly subscriber fee as a starting point, we consider four alternative geographical coverages:

1. A separate system for each of the 13 incorporated cities in the Dayton metropolitan area listed in Table 3. This case is useful in showing the possible consequences of each city "going its own way" in franchising cable operators, characteristic of the past development of the industry in the rest of the country.
2. A single integrated system covering all 13 incorporated cities served by six interconnected cable headends. This case is illustrated in Figure 4, where each headend (indicated by the heavy dot) serves a circular area or "district" with a radius of up to five miles.[16] Each headend has the same origination facilities assumed for each of the cities in Case 1; in addition, one headend has more elaborate facilities, for the use of all the districts.[17]
3. The same integrated system as in Case 2 but expanded to include within the outlined metropolitan area the unincorporated areas scattered among the incorporated cities. The unincorporated areas include a population of about 158,000 in addition to the population of the incorporated cities of about 426,000, as shown in Table 3.
4. In addition to the metropolitan coverage of Case 4, a still larger Miami Valley regional system covering some of the outlying communities in Montgomery, Greene, Preble, Darke, and Miami Counties as shown in Figure 5. This case is interesting in suggesting the limits to extending into semi-rural areas a high capacity two-way network.

Each of these four coverages will be discussed in turn.

The Separate-City Case

The strategy of having each separate city with its own system does not look promising. Advanced cable systems with local program origination and additional headend equipment needed to fill the large number of channels involve a relatively high fixed cost. Only if these costs are spread over a substantial base (perhaps 10,000 subscribers or more) does an independent system look attractive. Dayton and Kettering are the only cities that fall in this category. Our ten-year financial analysis discloses that at a monthly subscriber rate of $6.00 per month the city of Dayton by itself would do well. The internal rate of return (the equivalent annual rate of interest earned on money invested in the enterprise) would amount to about 20 percent. At a lower $5.00 per month rate, the internal rate of return would fall to 19 percent and at $4.00 per month it would fall further to 15 percent. The reason for the good estimated performance in Dayton arises from a population large enough

[16] This five mile radius is the estimated maximum distance tolerable for good quality reception at the ends of the cable. See Paper One. pp. 20.

[17] The cost of these origination facilities, as well as the other cost elements in the system design, are treated in Paper Two.

Table 3

POPULATION, DWELLING UNITS, AND STREET MILES, INCORPORATED CITIES, DAYTON METROPOLITAN AREA

City	*Population (1970)*	*Dwelling Units (1970)*	*Street Miles (1968)*	*Average Dwelling Units Per Mile*
Dayton	243,601	85,401	574	149
Kettering	69,599	22,809	207	110
Fairborn	32,267	10,156	95	107
Miamisburg	14,797	4,839	68	71
Vandalia	10,796	3,335	35	95
West Carrollton	10,748	3,476	40	87
Centerville	10,333	2,984	45	66
Oakwood	10,095	3,795	42	90
Englewood	7,885	2,585	30	86
Trotwood	6,997	2,294	25	92
Moraine	4,898	1,606	40	40[a]
Union	3,654	1,198	15	80
Riverside	447	146	2	75
Total	426,117	144,624	1,218	119

SOURCES: Population and Dwelling Units: For cities over 10,000 population, Bureau of Census, *1970 Census*, HC(V1)-37, February 1971. Population for cities under 10,000, Community Development Department, Dayton Area Chamber of Commerce, *Population Trends--Montgomery County*, February 1971; for those cities under 10,000 population, number of dwellings estimated by assuming a figure of 3.05 persons per dwelling (the overall average for the State of Ohio). Street miles: Transportation Coordinating Committee, Montgomery and Greene County.

[a]This figure is relatively low because of extensive land use for industry in the City of Moraine.

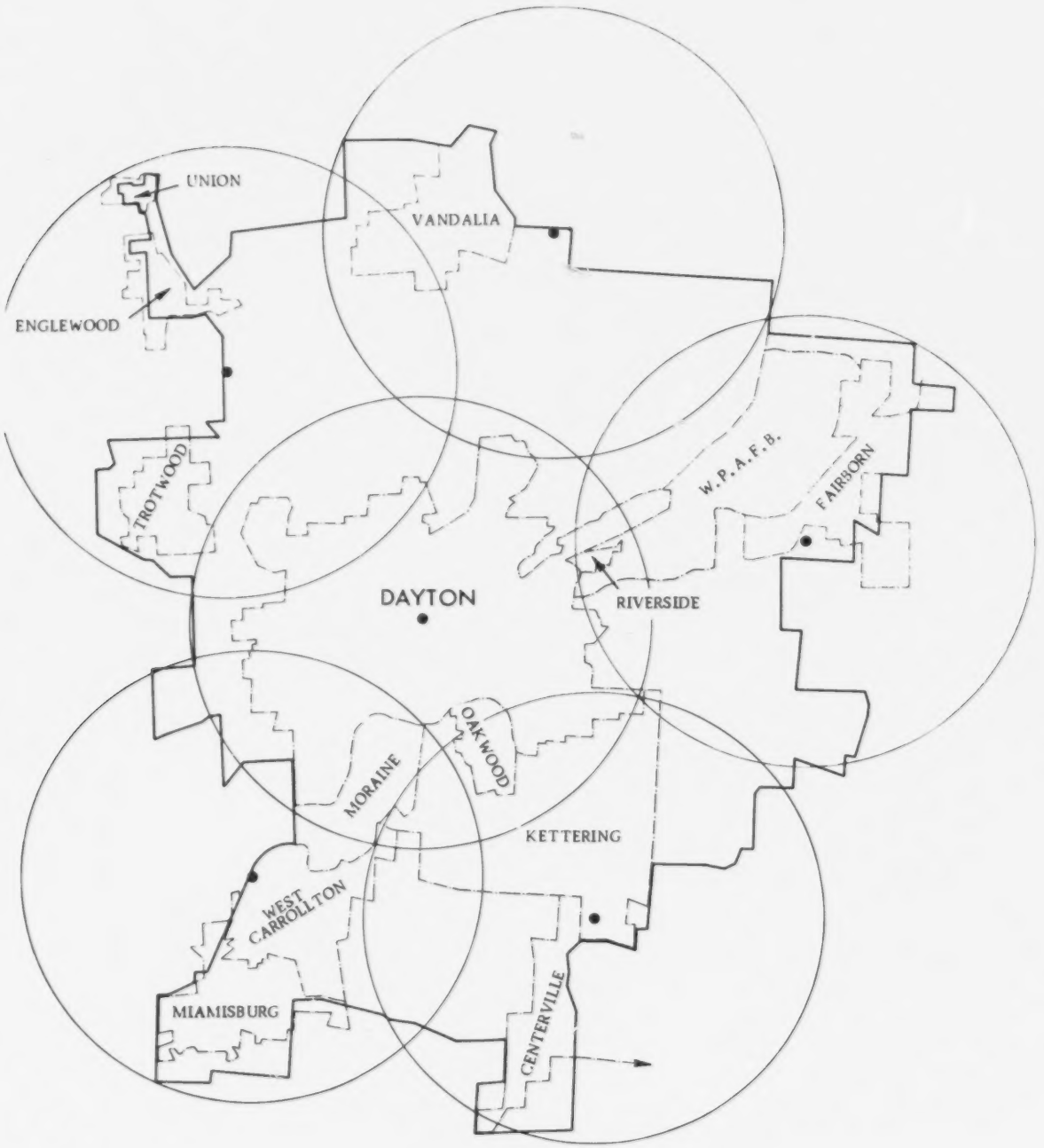


Fig. 4—Coverage from six headends

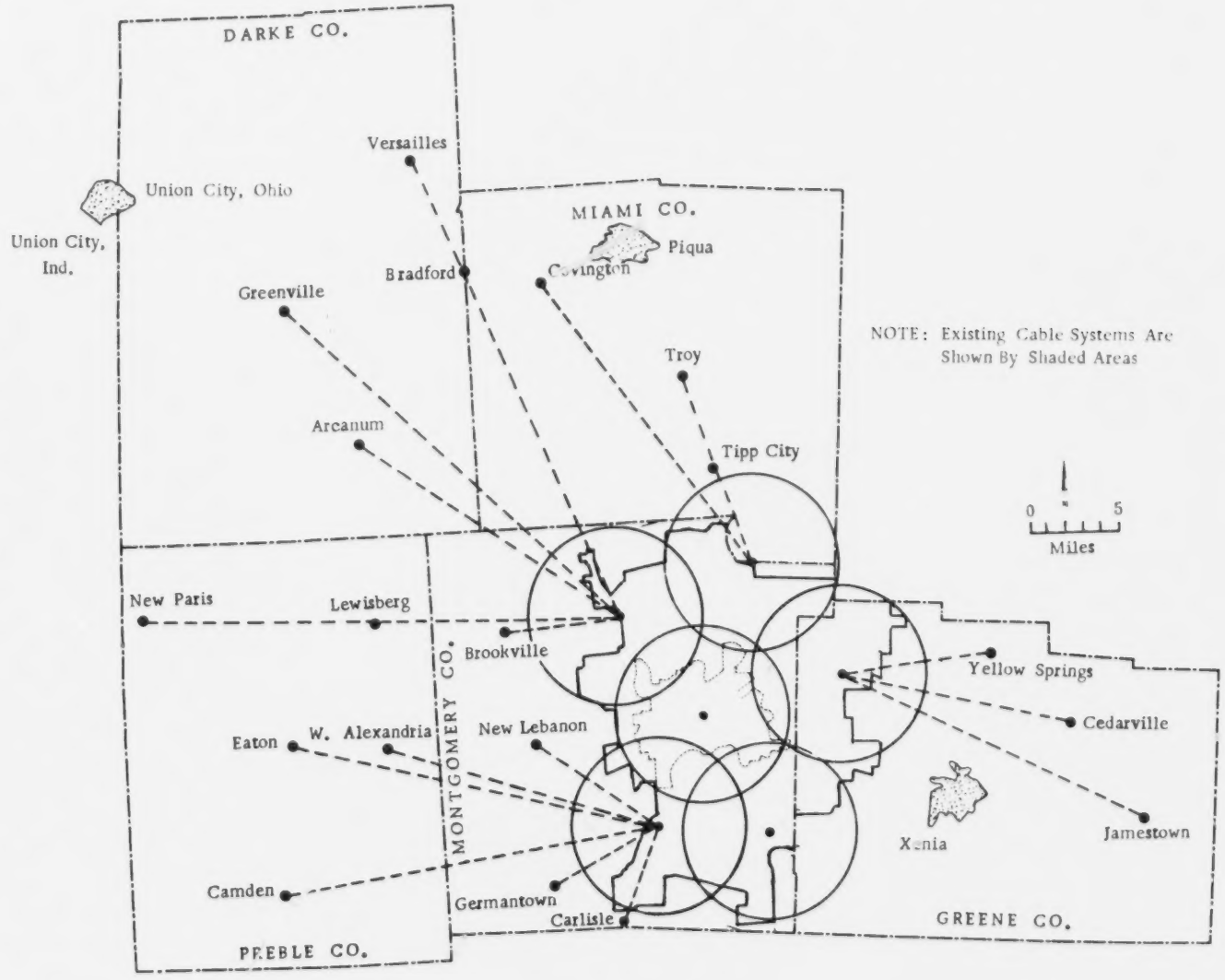


Fig. 5—Coverage of the Miami Valley region

to exploit the economies of scale and a high density of dwellings to reduce the cost per dwelling of cabling the area. Dayton's family income is somewhat lower than in the suburbs, but even taking income differences into account in their effect on penetration (as the above figures do), the city of Dayton is a promising market.[18]

The city of Kettering also comes out well, although for a different reason. Its population size and density are substantially below that for the city of Dayton, but its family income is higher.[19] At a $6.00 monthly subscriber fee and 40 percent penetration, its rate of return is estimated at about 13 percent (compared to 20 percent for Dayton), with the rate of return rising to about 16 percent if a fee of $8.00 per month were charged.

However, for *none* of the other 11 cities do our estimates show that *any* monthly fee, however high or low, would be sufficient to generate a positive internal rate of return. The size and density of population are too low, and family income is not high enough to compensate, to permit a positive rate of return—much less a return that could be considered "reasonable" for the funds invested.

The 13-City Interconnected System

With six interconnected headends shared by the cities as shown in Figure 4, the internal rate of return with the $6.00 average monthly subscriber fee would run to about 11 percent—lower than the 20 percent rate for Dayton taken alone. This design would permit greater sharing of fixed costs among several cities to render more feasible their participation in the metropolitan system. The population base would rise from the 313,000 total for Dayton and Kettering to about 426,000 for all twelve cities—an increase of about 30 percent.

A Single Metropolitan System

A more interesting case is one in which the unincorporated areas as well as the incorporated cities are included. Even though population density in the unincorporated areas of about 85 dwellings per street mile is lower than that for many of the incorporated cities, the overall rate of return *rises* from 11 percent to about 14 percent with their inclusion. (Moreover, if 2/3 of the investment were financed by debt at 10 percent interest, the return to equity would amount to about 17 percent). The reason for the improved performance is that the additional revenue generated in serving these areas from the existing six headends and interconnection facilities is substantially higher than the additional cost of serving them. In other words, expansion of the six cable districts to serve unincorporated areas would permit yet further sharing of fixed costs.

[18] Unfortunately, family income data from the 1970 census were not available at the time of this writing. Here, as elsewhere, we must resort to projections based on 1960 income data.

[19] According to 1960 census data, Kettering had a median family income of $8,441 compared with $6,266 for Dayton and $6,821 for all of Montgomery County. Bureau of the Census, U.S. Censuses of Population and Housing: 1960, Final Report PHC (1)-36, *Dayton, Ohio*, p. 15.

The metropolitan case is particularly important in light of the kinds of services that may be most attractive on cable along the lines discussed in more detail below. For example, if the cable system is to be used for external degree, vocational training, and adult extension courses, it makes a big difference whether a large or only a small student body can be reached. The university that can reach only one-third or one-half of the geographical area from which it draws students would likely be much less interested in using cable than if it could draw from the whole geographical area. As discussed in an earlier Rand report, the cost of televised instruction depends crucially on the number of students.[20] Similarly, the effectiveness of using channels for continuing medical education as discussed in the *Basic Report* (Paper Eight) would depend on the number of physicians who could be reached.

However, both the single metropolitan system and the 13-cities integrated system raise a policy problem—the degree to which one area is to be subsidized by another through a uniform pricing policy. Today public utilities, including the telephone industry, generally price on an "average cost" basis such that uniform rates are charged over a wide geographical area. This practice is defended on grounds that a single rate appears "fair" in view of the fact that the service is the same to all customers (although underlying costs may not be), and that it is relatively simple to administer. In the telephone industry the practice is further defended on grounds that the user paying a relatively high rate for his service helps to subsidize the use of telephones by others which in turn makes his own telephone service more useful. That is, the more people who have telephones, the more valuable is the service to everyone.[21]

Cable subscribers may also benefit from the fact that others are served by cable insofar as the broader coverage afforded through the metropolitan system may support services that are economical only for a large subscriber base. For example, the larger the subscriber base, the less cost per subscriber of offering locally originated programming, instructional services, and other applications discussed subsequently in this report. Thus, although a particular resident may pay more for metropolitan-wide cable service than he might in a separate system, he would also get more service. As a case in point, if a uniform fee of $6 per month were charged for the whole metropolitan area to generate the 14 percent internal rate of return mentioned above, than the residents of Dayton might pay a higher rate than they would in a separate system. The critical question then is whether the additional service they receive as a consequence of being a part of the larger system offsets this higher monthly fee.

In addressing this question, the Council of Governments has several alterna-

[20] Leland L. Johnson, *Cable Television and Higher Education: Two Contrasting Case Examples*, R-828-MF, September 1971. For these uses, the fact that fewer than half of the total dwellings may subscribe to cable is less important than the fact that cable would pass most of the homes so that anyone who desires instructional or specialized services could have *easy access* to cable channels by having a drop line installed to his home.

[21] However, the charging of uniform rates over a wide geographical area by the telephone company would tend to increase the total number of subscribers, and hence the value of service, only if the *reduction* in number of users in those areas that would otherwise pay a lower rate is more than offset by the *increase* in the number of users in areas that would otherwise pay a higher rate.

tives: (a) to adopt a uniform rate structure among the districts, analogous to that of telephone, on grounds that this is an administratively simple solution justified by the value of additional services provided by the metropolitan-wide system, (b) as a variant of the first, to establish a uniform fee but with many of the services of cable, including local origination, aimed at low income groups in the central city;[22] (c) to establish a differentiated fee structure which, at the extreme, would be based on the criterion that residents of each city pay more than they would for a separate system.

The Five-County Miami Valley Region

The discussion in the *Basic Report* (Paper Three) delineates the possibilities for providing about 18 channels of television plus a low data-rate feedback return channel to a number of outlying towns in the five-county area. A link with the metropolitan area could be of great service to the outlying scattered population. In addition to carriage of broadcast signals, elementary and secondary school programming, adult extension courses, continuing medical education, and some of the two-way services listed in Table 1 are leading candidates. Although the 18-channel capacity for the outlying areas is less than the 40 or so channels we have discussed with respect to the metropolitan region, still this would be a substantial increase over what is now available over the air.

However, several precautions should be kept in mind:

1. Regional service for the Miami Valley would require new kinds of high capacity microwave equipment now in development and only in limited operational use. This equipment is specifically designed for "local distribution service" (LDS) by cable systems. Perhaps by the time a Dayton metropolitan system is constructed the equipment will be perfected to the point where it can be used with high reliability on a widespread basis. Within the metropolitan area we are taking the more conservative approach of postulating the use only of conventional FM microwave facilities. When the LDS equipment is perfected, it could also be used within the metropolitan area as a substitute for FM microwave to increase substantially the interconnection channel capacities within the range of interconnection costs contained in the *Basic Report.*[23]
2. The towns and cities would obtain all of their programming from the metropolitan area through microwave links. Some local programming could be added but at a lower level of quality and quantity than we have assumed for the metropolitan area. In light of their small populations, coverage of the high fixed costs of advanced cable systems, as described in Paper One, would be out of the question. The local headend would consist of little more than a microwave tower and antenna with signals routed

[22] The suggestion for a uniform rate but with services of cable directed especially toward low income groups in the central city has been made by members of the Community Development Committee that was convened periodically during the course of the Rand study as described on p. ix.

[23] Paper One, pp. 30.

Table 4

CHARACTERISTICS OF OUTLYING TOWNS AND CITIES EXCEEDING A POPULATION OF 1500 WITHIN FIVE-COUNTY MIAMI VALLEY REGION[a]

County	Distance from Nearest Metropolitan Headend (miles)	Population	Housing Units	Approx. Street Mi.	Dwelling Units/Mi.
Darke					
Greenville	26	12,380	4,455	47	95
Versailles	28	2,441	855	14	61
Arcanum	18	1,993	736	10	74
Greene					
Yellow Springs	8	4,624	1,472	31	47
Cedarville	13	2,342	679	7	97
Jamestown	19	1,790	519	7	73
Miami					
Troy	11	17,183	5,818	59	99
Tipp City	6	5,090	1,706	22	78
Covington	19	2,575	914	14	65
Bradford (includes portion in Darke county)	21	2,163	696	9	77
Montgomery					
Brookville	7	4,403	1,447	17	85
New Lebanon	9	4,248	1,324	13	102
Germantown	7	4,088	1,404	16	88
Carlisle (includes portion in Warren county)	7	3,821	1,107	19	66
Preble					
Eaton	21	6,020	2,197	30	73
New Paris	27	1,692	534	5	107
Lewisburg	14	1,553	490	8	61
West Alexandria	15	1,553	490	9	54
Camden	21	1,507	475	8	59

SOURCE: See Paper Three, p. 6.

[a]Excludes those places with existing cable systems: Xenia (Greene county); Piqua (Miami county); and Union City (Darke county).

directly into the cable system without signal processing and other equipment required at a conventional headend. Given the costs of this microwave equipment, a system providing 2-way capability and some local program appears economic in the near-term only for towns of populations of more than 4000 as listed in Table 4. (For the small towns of 1500 or so it is questionable whether *any* form of cable service, conventional or advanced, would be economic in the near term.)

3. Signals at the high frequencies used by LDS equipment are affected by heavy rainfall and other weather conditions. The longer the distances covered, the greater the problem of occasional outages or poor reception as a consequence of local weather conditions along the microwave route. For this reason we judge that the maximum distance from a metropolitan headend shown in Figure 5 to an outlying town should be kept to about 20 miles.
4. For the lower population densities of the outlying towns, a single cable plus converter would probably be more economic than dual cable employed in the metropolitan area. Since the capacity of the system is limited by the microwave links, the potential additional channels provided by the dual cable plant would be of little value.

Despite these problems, a regional system would be able to provide many more channels, with limited two-way capability, than would be possible with conventional CATV. The only alternative open to these small towns would involve erecting a tall antenna (300 feet or so) and installing conventional headend equipment. Depending on how many signals could be picked up off the air, from Dayton, Cincinnati, and Indianapolis, 9 or 10 channels would be all that could be fed into the cable system. In comparison, the microwave link would have greater capability to provide both one-way and two-way service, yet would be no more costly than a conventional headend and tower installation.[24]

Lease Channel Revenues

The preceding financial analysis is based on quite conservative assumptions. It considers revenues only from home subscribers based on rates within the range being charged today for conventional CATV service. Yet it includes a cable distribution system with a far greater capacity to serve a variety of new uses if and when they are perfected. Even so, the analysis suggests that metropolitan coverage would be economically viable.

For purposes of the financial projections we do not estimate the revenues and the costs for the host of services of the sort listed in Table 1, because there is no satisfactory basis today on which estimates can be made. (In this area it is all too easy to be carried away with blue sky projections.) But we do consider one case where educational institutions lease ten channels at a "preferential" lease fee of $35,000

[24] Paper Three, p. 9

per year per channel to cover the metropolitan area, and where one channel is leased at $350,000 per year (ten times the preferential rate) for a special pay-movie channel leased by a movie program packager from the cable operator.[25] With these lease revenues in addition to subscriber fees of $6.00 monthly, the internal rate of return for the metropolitan system rises from 14 percent to 19 percent. Or expressed differently, the subscriber fee could be reduced from $6.00 to about $4.25 while keeping the internal rate of return constant at 14 percent.

The value of the exercise of including these lease revenues is to highlight the importance of channel leasing as a way to reduce monthly subscriber fees and increase cable penetration. A troubling aspect frequently mentioned in past discussions is that many potentially attractive services would be oriented toward low-income groups; yet many low-income people may not be able to afford cable at existing rates. Some observers feel that as a national policy, cable service should be extended to most or all households. As a case in point, the Citizens Advisory Committee on Religion—one of the committees that has met periodically during the course of the Rand study—recommends that "some means be devised whereby this system is made operational in every home regardless of the ability to pay and that program time be available to every citizen on a first come-first served basis."[26] One way to reach this goal is by generating large enough revenues for lease services to enable the fee for ordinary home subscribers to be reduced to near zero. The day of near zero subscriber fees is far off, and one would be on slippery ground at this time to attempt financial projections on that basis. Yet the objective of generating increasingly large revenues from leased channels, to the benefit of other users including home subscribers, is a worthy one.

[25] The preferential rate is based roughly on the incremental cost of supplying the additional channels for these services. The movie channel is priced much higher to illustrate the principle that if commercial users bear much of the overall cost of the cable system, other users including home subscribers may benefit in the form of lower fees. See Paper Nine, p. 35.

[26] The full statement of the Citizen's Advisory Committee on Religion is included as an appendix to the *Basic Report*.

III. NEW AND EXPANDED SERVICES

Many potentially attractive services have already been treated in the literature and the discussion need not be recapitulated in detail here.[1] For examples of services that would be available at the time the cable system is completed, we will concentrate on local program origination for community needs, instructional uses, and special pay channels for movies and sports. For examples of potentially attractive services in the longer term (dependent largely on the development of new terminal devices) we will treat facsimile mail, information storage and retrieval, municipal alarm and traffic control, as among the more promising possibilities.

LOCAL COMMUNITY PROGRAM ORIGINATION

One of the most widely discussed possibilities for use of cable is in transmitting programming to meet the interests of particular small groups at a cost far below that involved in conventional over-the-air broadcasts. The *Basic Report* (Paper Four) describes the social geography of Dayton and suggests the various communities of interest that exist on the basis of voting behavior, race, age distribution, and other characteristics. Since it is possible to provide different local programming on each trunk line radiating from the headend into these communities of interest, audiences could be pinpointed for highly specialized programming—audiences miniscule in comparison with what broadcasters are accustomed to, but still large enough to fill an auditorium. Or, at the flick of a switch, the same program could be carried on all the trunk lines to cover the whole cable district for programming of wider interest. Or, at the flick of another switch, the program could be carried over the microwave interconnection facility to the other five districts for metropolitan-wide dissemination. Moreover, in the five-county regional system it could also be sent to a number of outlying small towns.[2]

[1] Many references to the literature are contained in Baer, *Interactive Television.*

[2] A number of cable operators are already originating programming, particularly in Canada where the largest cable systems in the world are located. See N. E. Feldman, *Cable Television: Opportunities and Problems in Local Program Origination,* R-570-FF, September 1970.

One factor that would help is the possibility of sharing use of studio equipment and personnel of the new non-commercial television station, Channel 16, soon to come on the air. In fact the station might play a major role in feeding a number of cable channels for classroom instruction and for other educational services described below.

How the cost of this programming is to be covered remains open. Our financial projections include the cost of studios, other equipment, and technical personnel required for a total of 60 hours per week at the central studio and 30 hours per week at each of the five program origination facilities serving each of the five districts. However, the quantity and quality of programming making use of these supporting facilities will depend on the level of additional funding for talent and other program elements. The question of who pays and who has the responsibility for deciding how the money is to be spent for programming is a major issue.[3]

The *Basic Report* (Paper Five) describes some of the public interest programming that might be carried; we shall tabulate here only some of the more promising possibilities.

- A community ombudsman handling questions and answers, complaints, and general information to improve relations among the public, government, and business.
- Consumer reports including comparative product data and consumer economics.
- Local news and information pinpointing communities and neighborhoods, including serving the interests of minority groups, in a far more effective manner than is possible with over-the-air broadcasting.
- Coverage of a variety of local events including important city council meetings, PTA meetings, government hearings, town hall meetings.
- Coverage of political campaigns, including cable access to local political candidates (with questions and answers possible on two-way channels), infeasible with over-the-air broadcasting.[4]

The public opinion survey discussed in the *Basic Report* suggests that such programming may serve important needs. Not only did many of the respondents say that they would be interested in watching locally originated programming, but fairly large numbers have watched locally originated public interest programming offered by broadcasting stations in the past. Moreover, the survey discloses that the racial differences do exist in the uses and interests in television. The ability of cable to pinpoint particular neighborhoods and communities, may contribute greatly to serving these differences.[5]

[3] The issue of funding is discussed in Paper Nine, pp. 45-46.

[4] For an account of how a cable system has, in fact, been employed to provide access to local political candidates, see Herbert S. Dordick and Jack Lyle, *Access by Local Political Candidates to Cable Television: A Report of an Experiment*, Rand R-881-MF, November 1971.

[5] Paper Six, p. 31.

INSTRUCTIONAL USES

Adult and Higher Education

The growth in the Miami Valley of cable television, with its many channels and the possibility of two-way feedback, could have a dramatic effect on the educational process. By permitting students to take instruction in the convenience of their own homes, it could greatly expand opportunities to pursue higher education, career-based instruction, high school equivalency, in-service teacher training, and other learning activities. By including feedback from the home terminal, interaction with the instructor on cable would permit enrichment of the learning process. If good instructional programming can be developed and shared widely, cable television could reduce the overall cost of education.

The use of television is, of course, not new in the instructional field. Conventional non-commerical broadcasting stations are heavily involved especially in supplying programs for elementary and secondary schools. Some campuses have closed-circuit cable systems to provide televised offerings in classrooms and to on-campus dormitories and other residences. However, cable television would have several advantages:

- It provides many more channels than can be supplied by conventional broadcasting stations to permit greater flexibility in scheduling course material. It is not enough that a course be offered at, say, 2:00 p.m. on Tuesdays and Thursdays if a large proportion of the students are unavailable at that time. Nor is it sufficient to schedule at 6 to 7:00 a.m. or during the dinner hour as some broadcasting stations are doing.
- It reaches students in their own homes or in other remote locations not covered by campus closed-circuit systems. A major difficulty, especially in high school equivalency or vocational instruction, is that the bulk of the students work part time or full time and, in some cases, live far from places where instruction is ordinarily given. This is not to suggest that television is a satisfactory substitute for all live instruction but rather that it could facilitate access to instruction that otherwise would be denied.
- It offers the possibility of rapid feedback from the student during the course presentations if a two-way capability is built into the system. Much criticism has been leveled at television for instructional purposes as being too passive. Although television is sometimes combined during the day with live instruction to provide an overall high level of interaction between the student and instructor located close together, as on a college campus or in an elementary schoolroom, the problem of maintaining effective interaction is more serious for students *remotely* located from the instructional source.

To illustrate some of the possibilities, we will explore several examples:

Higher Education. Consider a case in which some hundreds of students who have access to cable in their homes sign up for a televised course that ordinarily would be conducted only on campus. At registration, each student is provided with a push-button response terminal to be attached to his television set and to the two-way cable system. The instructor gives live presentations over the cable several times a week as a substitute for classroom instruction: With the feedback mechanism the instructor can pose true-false and multiple choice questions to which each student can respond by pushing the appropriate button on his feedback terminal. Each response goes into a computer and from there into a printout immediately available to the instructor. The instructor can then modify his presentation accordingly. For example, if No. 3 is the correct answer but a large number of students answer No. 1, he can take extra time to explain why No. 1 is wrong. Conversely, if most students do well in questioning, the instructor can move quickly to the next subject.

Moreover, if many students persist in having difficulties, remedial televised presentations could be offered on an *ad hoc* basis with additional questions, answers, and explanations. For example, the instructor might respond:

> About one-half of you are answering incorrectly the questions I have just posed. For those of you who are continuing to have difficulty, please reread pages 30-45 in your text, and we will have an additional televised discussion this evening at 8:00 p.m. on Channel 24. If you cannot participate tonight, a videotape of the discussion will be repeated tomorrow at 10:00 a.m. and again tomorrow night at 8:00 p.m. on Channel 35.

Again, the advantage of cable is its multi-channel capacity: it can offer flexibility in scheduling courses and special sessions, tailored to the individual needs of students in ways that are out of the question with today's instructional television.

With respect to applications in higher education, one institution in the Dayton area, Wright State University, is a leading candidate for using cable channels in the way described above. Wright State, a relatively new addition to the state system of higher education, is essentially a commuter college currently serving about 11,000 students, most of whom drive to class. Evening enrollments are nearly as large as those during the day. Such a new and growing institution, whose goal is to provide easier access to higher education, might be in a particularly good position to offer programming over a number of cable channels.

Vocational Education. Let us consider another case, one of small enrollments encompassing perhaps 30-40 students where voice rather than simple digital feedback might play a major role: scattered about the metropolitan area are child day care centers staffed largely by volunteers and para-professionals. Course work for upgrading the skills of the para-professionals may be available at some nearby college but it is not easy for them to attend class on a consistent basis, because they work during the day and they have their own children to tend in the evenings. However, with cable, live televised courses can be offered to them during nap time

at the day care centers. With a voice terminal on their receivers they can not only respond to questions posed by the instructor but also ask questions or raise points directly, using the instructor's televised "classroom" as a forum.

High School Equivalency. Here we can visualize combinations of the above. A relatively small number of students, let us say taking senior English at home, might use a voice-digital terminal for the same kinds of interaction mentioned in the preceding application. Larger enrollment courses would use digital feedback as discussed previously. In both cases students would occasionally go to the school for special tutoring, other help and examinations as the need arises.

A Note on Costs and Benefits. In all these cases we have in mind technology that will likely be available in the next few years. At least four manufacturers already have two-way terminals in development. Although in prototype form they cost between $300 and $500, they would probably be available for $100 or less in mass production, and on lease basis for perhaps $30 per year. The cost of cable service, with the two-way terminals, may be less than even the travel time and direct travel costs of students who today drive to class. In Table 5 we assume that 5,000 students, ordinarily driving to class four times a week, 45 weeks per year (including summer session), would need attend only once a week with televised courses available in their home.[6] Although the table does not include the other elements of the instructional process (for either conventional or televised instruction) it does indicate, rather strikingly, that travel cost saved by substituting some home instruction for conventional course offerings to commuting students would more than offset the cost of home terminals equipment and cable service.

Elementary and Secondary Education

Since the *Basic Report* (Paper Seven) deals extensively with the potential use of cable for elementary and secondary schools. we shall only note that, among other things, the number of channels available to elementary and secondary classrooms would permit teachers to have demand access (perhaps with some queuing) to a central library of video tape and film programs to be viewed at their choosing. A major problem with today's classroom television is its inflexibility. With only one or a few channels available, it is generally not possible to schedule programming in a manner most convenient for individual teachers, whose schedules are necessarily dictated by the particular pace of the class and the needs of individual students. To attain greater flexibility with cable the metropolitan network could be broken down into subnetworks at one time of day and reconstituted later into the full network to accommodate the shifting patterns of need. Thus, the individual cable subnetworks covering perhaps one or a few school districts, as in Oakwood or Kettering, could provide many channels during the school day on a closed circuit basis to the individual schools and classrooms within the district. Separate programm could

[6] This number of students is less than half of those who today commute to Wright State University.

Table 5

AN ESTIMATE OF ANNUAL SAVINGS IN TRAVEL COST FOR 5000 STUDENTS

Conventional Instruction		
Direct travel cost (4 trips per week, 45 weeks, average round trip distance 20 miles, 5 cents per mile)	$900,000	
Cost of travel time (40 minutes per round trip, valued at $1 per hour)	600,000	
Total cost		$1,500,000
Televised Instruction		
Direct travel cost (1 trip per week)	225,000	
Cost of travel time	150,000	
	375,000	
Add: Lease of 2-way terminals (including converters) at $40 per year	200,000	
Cable installation $15 (60% of students)	45,000[a]	
Cable monthly subscription 12 months at $6 (60% of students)	216,000[a]	
Cable channel lease (3 equivalent full-time channels)	105,000[b]	
Microwave Interconnection Lease	32,000[c]	
	598,000	
Net savings		527,000

[a] These figures are based on the assumption that 40 percent of the students would already have access to cable service (the percentage estimated for the population as a whole in our financial projections).

[b] Includes $35,000 per channel for cable distribution from Paper Nine, p. 33.

[c] Includes $10,300 for each of three outbound microwave channels and $1000 for a portion of an inbound channel for digital response, from Paper Nine, p. 36.

be transmitted on each of the three or four trunk lines radiating from the headend to add that much more to programming flexibility. The same channels connected into the larger district or metropolitan network in the evening could then be used for external degree programs, adult education, and other post-secondary applications. If several institutions share the use of those channels, the channel lease fees paid by each would be commensurately reduced.

Potential Medical Uses

The *Basic Report* (Paper Eight) deals with the possibilities of continuing education for physicians. One or more private channels on the cable system could provide instructional programming at the convenience of individual physicians in their own offices or homes. It may be possible to arrange a dial-up service that would permit individual physicians to select the programming to be shown on their own television sets at specific times. This flexibility in use is particularly important for physicians whose daily schedules are uncertain and frequently hectic.

With the cable system interconnecting hospitals scattered around the Dayton area, programming could be originated economically from a central location and fed to all participating hospitals. Individual programs would be repeated a number of times to permit interns and physicians to view them at convenient times. Two-way interactive instruction could also be introduced to permit live presentations, with questions posed by interns in scattered locations to be answered on the spot.

Training materials could also be offered on the interconnected hospital network as well as on private channels going into nurses' residences. Depending on traffic loads on the cable system, nurses, too, may be able to dial-up a particular program at their own choosing. For example, a nurse on a night shift having only sporatic duties connected with patients' care could request programming with a 2-way terminal device on her television set at her desk. If she is interrupted by a patient call, she could turn off the videotape machine by remote control and resume running the program when she returns to her desk.

SPECIAL PAY CHANNELS FOR HOME USE

One of the most promising prospects for cable in the near future is use of special channels in the home for offering recent movies, sporting events blacked out in local television markets, and special cultural events. For example, for a few dollars a month in addition to his regular monthly cable subscription fee, the viewer may be able to see two or three movies per week, perhaps already showing in local theaters but not yet available on broadcast television. Similarly, he might have access to sports events blacked out on local television, and to a range of cultural events beamed, say, from New York's Lincoln Center for the Performing Arts as well as from local theater groups. Conceivably, the revenues for these cultural events might substantially strengthen the underpinnings of such places like the Lincoln Center and the Los Angeles Music Center which, along with the performing arts in general, have been in serious financial straits.

The use of special pay channels may be important, if not crucial, to the viability of cable in major cities. For it is one potentially popular and profitable service not now available on regular television, and it would use terminal equipment already in advanced development. As we have seen, lease revenues from a pay-movie channel could contribute substantially to the revenues of the Dayton metropolitan cable system, benefiting other users.

Such pay channels may work to the special advantage of low income groups in the central city. Aside from the probability that the price would be low relative to ordinary box office admissions, people in the central city would have easier access to entertainment. Although the number of movie theaters has not significantly declined nationwide in recent years, there has been a flight to the suburbs along with population. In central Dayton hardly any theaters remain in operation and virtually all of those specialize in "adult fare."

The question of pay television has been and still is a hot political issue. Theater owners and television broadcasters have bitterly fought the development of pay television, using as their argument the possibility that it would "siphon off" programming that otherwise would have been seen on conventional television. That is, the television viewer would end up paying for what he would otherwise have been able to see for free. However, the FCC has recently promulgated rules that would reduce this threat. Among other things, only movies no older than three years and sports events not ordinarily seen on television, are to be eligible for inclusion on special pay channels. Although these rules are not foolproof (as theater owners are the first to point out), they probably are sufficient to permit the growth of pay entertainment channels that will contribute both to the viability of cable operations and, by offering yet more choices in programming, to the welfare of the public.

FACSIMILE MAIL

Today information on paper can be transmitted electronically by telecopier machine connected through the telephone handset into the switched national telephone network. With conventional telephone lines it is possible to transmit directly from one terminal to another anywhere in the country for the price of a long-distance telephone call. Since it takes 5 or 6 minutes to transmit information on a single page, however, this can be rather expensive and time consuming. If terminals are developed to exploit cable's broadband capability, it may become possible to transmit as rapidly as paper is today fed into duplicating machines. The transmission would go from the terminal to the headend on the two-way channels, and thence to another point within the cable system or, by microwave or communication satellite, to any other terminal in the country or, for that matter, in the world. Thus, high priority mail even of a fairly bulky sort could be sent quickly from one terminal to another.[7]

Initially, we visualize such service being provided by relatively expensive terminals from post office to post office with delivery at the receiving end made in the conventional and relatively slow fashion. But as terminals become progressively less

[7] In this application, as elsewhere, the question of privacy is obviously important. Given the party-line character of broadband communications, the delivery of mail would have to be arranged in such a way that only the terminal to which it is addressed is able to receive it. The extent to which privacy can be maintained depends on the cost one is willing to incur. For a discussion of the problem of privacy see Baer, *Interactive Television*, pp. 81-84.

expensive they would be used for direct business-to-business use, circumventing the bottleneck in local distribution. Perhaps in the more distant future, terminals would be inexpensive and compact enough for home-to-home use.

This potential application highlights the importance of the local distribution function of cable. We have already seen revolutionary advances in long distance transmission—the substitution of microwave for open wire, the development of communication satellites to permit a drastic lowering of the cost of international communications, the current plans to use satellites domestically as well, and also development of the "circular wave guide" through which several hundred thousands of telephone calls could be transmitted simultaneously across the country at much lower cost per call than is possible today. But we are familiar too with the problem of local distribution: the overcrowded local telephone circuits, and slow mail delivery even within a single postal zone (or, to step into another field, the arduous drive from airport to home after a quick and comfortable flight). The development of urban broadband cable communications may break through these bottlenecks and permit us to "catch up" with the technological advances that have been so dramatic in long-distance transmission.

INFORMATION STORAGE AND RETRIEVAL

The enormous capacity of modern-day computers, plus the development of new terminals combined with the broadband capability of cable, may facilitate the storage of masses of material and permit the retrieval of information on a highly selective basis for a wide range of business, industrial, and government uses. Terminals are under development today that can present frame-by-frame information selected by the viewer. With this so-called "still frame" technique it is possible to feed perhaps as many as 300 terminals simultaneously with a single TV channel. Such specialized users as travel agents, stockbrokers, libraries, and government agencies may find this capability valuable in the near term. (As one example, it may permit transmission of high priority information among police departments such as continuously updated lists of wanted persons and vehicles). Although the cost of still-frame terminal equipment is likely to be excessive in the foreseeable future for ordinary home use, it may become an important factor elsewhere.[8]

ALARM INTERCONNECTION AND TRAFFIC CONTROL

In Dayton, dedicated and leased lines today connect several hundred street-side fire alarms. Much of this network is deteriorating and will have to be replaced in the not-distant future. With broadband capability, cable might perform this function

[8] For a discussion of these terminal costs and prospects for the future, see Baer, *Interactive Television.*

at a fraction of present-day costs. Likewise the control of street lights geared to traffic patterns might be provided by cable. Television monitors at critical intersections, as well as along pedestrain walkways, might also serve an important role in traffic control and public safety.

These applications are speculative to the extent that terminal equipment to perform these tasks has not yet been perfected; moreover one would need a careful cost comparison with telephone leased lines in order to make final judgments. Still, this is one of the many areas where, over the next decade, cable may play a role transcending its present use of merely retransmitting broadcast signals.

OTHER POSSIBILITIES

The above description of potentially new and attractive services includes only a few that have been mentioned in the past. Others that come immediately to mind are: closed-circuit two-way video conferences among government and business groups; fire and burglar alarm services for home and business (if the serious problem of false alarms can be solved); meter reading and control of electrical loads in response to peak power demands; centralized computer computational services; teleshopping; preschool reading readiness; and others. But the preceding is perhaps sufficient to give the reader a flavor for what may be in store in the future and why the development, ownership, and regulation of cable technology is a vital area for public attention.

Table 6 illustrates how the many channels on a 40-channel dual cable system might be employed for the services described above. This tabulation is not meant to imply that these are the *particular* allocations that will or should be made, but merely to illustrate the fact that ample channel space is available for a wide variety of needs as they arise.

Table 6

ILLUSTRATIVE USES OF CHANNELS

Number of Channels	Use
Examples of Channels Available to All Viewers	
9	Commercial Broadcasting Stations
1-2	Noncommercial Broadcasting Stations
1	Metropolitan Community Programming
1	Local Community Programming
3	20 to 30 FM Radio Stations[a]
4-5	Additional Channels
Examples of Additional Channel Uses for Specialized Purposes (Set-Top Converter Required)	
10	Instructional uses
2	Medical and Public Health
2	Police and Other Government
1	Pay Movie Channel
1	Pay Sports/Cultural Channel
4	Additional Bandwidth for Facsimile Mail, Information Storage and Retrieval, other uses by Business, Government and Industry

[a]Equivalent television channel bandwidth required to cover FM radio band.

IV. FRANCHISING AND OWNERSHIP OF CABLE SYSTEMS

ISSUES IN FRANCHISING

The *Basic Report* (Paper Nine) treats a number of areas that must be considered by the Miami Valley Council of Governments in proceeding with franchising:

- Duration of franchises
- Exclusive vs. nonexclusive franchises
- Geographical coverage
- Serving low income areas
- Single vs. multiple ownership
- Allocation of channels to public agencies
- Common .carrier status
- Public regulation of rates and profits
- Public access and local program origination
- Construction timetable and technical standards
- Local franchise fees
- Television set leasing by cable operators

With respect to duration of franchises we conclude that ten years would be an appropriate figure. The probability is low that the owner of the franchise would be expelled at the end of the ten-year period for the same reason that broadcast licenses, although renewable every three years, seldom change hands as a consequence of government refusal to renew licenses. But the expiration of the franchise does serve as a convenient point to review the performance of the cable operator, and it provides an opportunity to renegotiate basic conditions of the franchise on the basis of the experience accumulated over the preceding period.

We conclude that nonexclusive franchises would be superior to exclusive ones. In the latter case the cable operator is assured that no competing applicant will be certified in his franchise territory. In the former case the door is left open to competitive entry as a safety valve if the cable operator performs badly. Although, as a practical matter, the existing operator would have a strong advantage over new

entrants, and although we do not view competition between cable operators on a home-to-home basis as feasible, still the nonexclusive approach carries the *threat* of competitive entry and may help to stimulate good performance by the cable operator.

With respect to geographical coverage, it would probably be unwise to require the cable operator to build a plant passing 100 percent of the homes in his franchise territory. Because of quirks in geography and other factors it will probably turn out that some small percentage of homes, say 5 to 10 percent, would be inordinately expensive to wire. To require the operator to serve them would impose a heavy cost burden on other users. Although differential pricing may assist him in wiring difficult areas, the complaints from a few subscribers about "unfair" treatment would limit the degree to which differential pricing could be employed.

In past discussions much concern has been expressed about serving low income areas. However, we conclude that this problem would be alleviated in Dayton, where the high density of population within the city and particularly in the black community would reduce the cost of serving each home. This is reflected in the fact that our financial projections show that Dayton by itself may do well. The problem is not so much whether the low income areas can be adequately served, but more whether differential prices are to be charged reflecting the differences in underlying costs, or whether uniform prices are to be established, but perhaps with special efforts made to direct the benefits of cable toward low-income groups.

With respect to single versus multiple ownership, separate ownership of the six districts would provide valuable yardsticks for comparing the performance of one cable operator against another. It might also assist in expediting construction of cable in the separate districts, and it would reduce the capital requirements that each cable operator would face. On the other hand, common ownership of the districts would alleviate problems of (a) defining geographical boundaries among the districts, (b) maintaining compatible technical and design standards to permit effective metropolitan-wide coverage, (c) sharing costs of common facilities (such as central studios), and (d) more generally, avoiding the struggle among applicants for the most profitable territories. Moreover, if a uniform subscriber rate were to be set among all districts, some districts might be quite profitable while others might lose money. If so, transfers of funds from the former to the latter would be required for cross-subsidization. This transfer process would be more difficult to accomplish with separate ownership. In principle, the franchising agreement could be carefully written to avoid these problems and to facilitate the development of separately owned districts, but in practice this would be difficult.

The allocation of channels to public agencies is a major topic of debate. Many have urged that large blocks of channels be made available free of charge to particular educational, government, and other public uses. However, we must remember that *someone* must pay the cost. If certain users are given free service, then other users must pay. As we have shown, provision of channels to public agencies on a lease basis, even at relatively low "preferential" rates, could generate substantial revenues that would benefit ordinary home subscribers.

Another topic of debate relates to whether cable operators should be regulated

as common carriers; that is, whether they should have no control over the content of particular channels, but rather stand ready to offer on a nondiscriminatory basis channel access to any and all users in accordance with published tariffs. In response, the Sloan Commission on Cable Communications has concluded that:

> . . . imposition of common carrier status would be unrealistic and an impediment to the desirable growth of cable. We do not believe that investors would be willing to undertake the substantial capital expenditures of laying cable if they had no control over the use of the channels in the formative years and so were powerless to control the financial destiny of the system[1]

However, distinguishing between common carrier status and public utility regulation, we conclude that cable operators might well be able to operate as common carriers without serious handicap *if* they have wide latitude in the early years to control and adjust lease rates for channels in order to test various markets and to seek profits commensurate with the underlying risks. Only if and when services vital to the public are developed on cable and the business becomes lucrative, would it seem necessary to move toward public utility regulation, similar to that of the telephone industry, where the overall rate of return is controlled and the level and structure of lease rates are closely supervised. Although public utility rate regulation has many problems, of which both the regulators and the regulated are painfully aware, it is hard to visualize cable performing a host of vital public services, with heavy elements of natural monopoly, without a strong measure of public control.

So far as channel capacity is concerned, we see little problem in public access. On a 40 channel system with 20 channels of basic service to all subscribers there will be ample channel space for local groups desiring to originate programs. A far more serious problem is that of funding. Who is to pay for the programming and who is to decide how to spend the money? This is one of the stickiest problems that the Council of Governments will face in proceeding with franchise negotiations.

Rigorous construction time tables and technical standards should be imposed both to prevent speculation in franchises by holders having no intention to build systems, and to provide adequate standards of service. As has been widely observed it makes little sense to control rates unless quality of service is also controlled. The Federal Communications Commission is well aware of these problems and is proposing to set down both construction time tables and technical standards that may be sufficient for the Miami Valley.

Unfortunately, many cities regard cable largely as a potentially lucrative source of tax revenue. The tendency is to grant the franchise to whichever applicant offers the city the largest amount of money, either in lump sum or as a percentage of gross revenue. However, cities might better concentrate on the kinds of services the cable could perform to alleviate problems the cities themselves face rather than to look on cable merely as a source of revenue. In the Miami Valley we recommend

[1] Report of the Sloan Commission on Cable Communications, *On the Cable*, McGraw Hill, New York, 1971, p. 148.

the franchise fees be kept low in order to provide more leeway in developing cable services that might contribute far more to the public interest than would the uses of forgone tax revenues. In fact, the Council of Governments should consider waiving franchise fees entirely under the condition that a stipulated percentage of gross revenues be devoted to locally originated programming and to other public services.

Finally, we recommend that cable operators be permitted to lease television sets along with cable connection as an integrated package. This would enable them to lease specially designed sets for cable and might also enable them to reduce the maintenance and purchase costs that the television viewer would otherwise incur. It is not clear that the cable operator would have an advantage over retailers and repair shops in supplying and maintaining specially designed sets. But he should have the opportunity to find out. If he fails, then nothing is lost; if he succeeds, then his success would serve the public interest.

OWNERSHIP ALTERNATIVES

Private, government, and non-profit ownership are the three general alternatives for cable systems in the Miami Valley. Each form of ownership has its own strengths and weaknesses measured against "public interest" criteria such as low subscriber fees, quality of services, commitment to local origination, ability to provide "free" educational and municipal services, willingness to innovate, and responsiveness to the community. But not all of these criteria can be fully satisfied at the same time. The cost of providing "free" services to the schools, for example, must be covered somehow by increased subscriber fees or by providing less of some other service such as local origination. These tradeoffs must be made regardless of the choice of cable owner and must be treated explicitly by the Council of Governments in drafting cable franchises. The public benefits from cable will be determined as much by the terms of the local franchises as by the form of system ownership.

Private cable system ownership is an attractive alternative in the Dayton metropolitan area if strong, compatible franchises can be written and enforced. No single franchising authority now exists in the Miami Valley that could franchise a regional cable television system. However, the Council of Governments has present authority to coordinate cable franchises and may, in fact, be able to draft a common franchise that can be adopted by its member municipalities.

Private ownership brings potential advantages of management experience, an ability to raise private equity and debt capital, and profit-seeking incentives for efficient system operation. The city of Dayton itself clearly represents a prize plum for a commercial cable operator, and other cities such as Kettering and Fairborn have already encountered considerable interest in franchising. However, commercial cable companies would find it less attractive to build advanced cable systems in the smaller communities surrounding Dayton or in the unincorporated areas of Montgomery and Greene Counties where per-subscriber capital costs are high.

Lowering the cost of capital would encourage a private owner to serve low density areas. This might be accomplished by financing cable construction outside of Dayton proper through tax-exempt, industrial development revenue bonds issued by Montgomery County with approval from the County Community Improvement Corporation (C.I.C.). The cable system would be owned by the county and leased to a private operator. This approach would represent a unique application of industrial revenue bond financing, but one that seems compatible with present C.I.C. authority and objectives.

The second general alternative is direct government ownership. Municipal cable systems could be financed through the sale of municipal revenue bonds and operated as a city department or agency. Or a municipal system could be operated by a private company under a management contract from the city. Municipal ownership, however, would not aid in creating an interconnected, regional cable network, nor in serving unincorporated areas.

One way of creating a regional, publicly owned cable system would be to establish a special authority similar to those now authorized for regional transit or airport facilities. Such an authority could issue its own general obligation and revenue bonds. It could build a single, interconnected cable system unconstrained by existing municipal boundaries. However, creation of a regional cable authority would require special enabling legislation from the Ohio State Legislature—a precedent that might be opposed vigorously by private cable interests and by those who would see it as a diversion from more important government tasks.

The third alternative is non-commercial cable ownership, either through an existing non-profit organization or (more likely) through a consortium of public-interest groups. The principal difficulties with the community group or consortium approach are (1) determining who is eligible to participate and how decisions are to be made; (2) fixing ongoing responsibility for building and operating the system; and (3) financing the system. There is scant precedent for the successful operation by community groups of large, multi-million dollar projects as complex as a broadband cable system. And raising capital to build a system also would be more difficult for a community group than for an established institution, public or private. Bringing in a commercial cable operator to manage the system under contract from the non-commercial group might make system financing and operation more feasible, but the difficulties should not be underestimated. Non-commercial ownership of a large cable system would be a pioneering effort and would demand a very strong commitment for success from the communities, organizations and individuals involved.

The arguments for government or non-commercial rather than private ownership are (a) more direct responsiveness of the system to public policy considerations, (b) direct application of system profits to public uses, and (c) use of such systems as "yardsticks" for comparison with private operations. A government or non-commercial system might be more likely to hire and train unemployed workers than a private system, for example, or it might extend service to low-income areas more readily. But, as stated above, each of these public benefits can be achieved only at

the expense of others. And those benefits that are explicitly recognized as important —minority hiring, for example—could be required in a franchise with a private owner.

A government or non-commercial system would not have to return profits to shareholders. However, the profitability of technically advanced, high capital cost cable systems in major markets is not at all sure, and it is almost certain that these systems will incur large operating losses at first. By owning the system itself, a city would be sacrificing franchise fees and other tax revenues in the early years in hope of receiving higher net revenue in later years. Such a calculation of future benefits is sensitive to small changes in assumptions of penetration level, subscriber rates, and operating costs; and any "expected value" of financial advantage from government ownership would be clouded by a far greater range of uncertainty. This argument would apply even more strongly to a non-commercial system, since its net operating income would be further reduced by franchise fees or other direct payments to the community.

The "yardstick" argument is probably the most important from a national viewpoint. As broadband cable systems begin to be constructed in the large cities, it would be useful to have some models of major government or non-commercial cable systems for comparison with private ownership. A few such examples would not lead to a rush toward public ownership, as many in the cable industry profess to fear. But they would allow direct comparisons in operating systems of the advantages and disadvantages of each approach.

Many of the past arguments for government or non-commercial ownership have really been arguments against private control of cable channels. There is much to be said in favor of this view that program control should not be left to the particular private individuals or corporations who own cable systems. Yet the question of who controls access—the "gatekeeper" function—can be separated from the question of ownership.

It would be easiest to have the cable system owner also serve as gatekeeper, but there are no compelling reasons why this must be the case. In fact, it would seem best *not* to have a government gatekeeper, in order to eliminate any possibility of government censorship or other First Amendment problems. A non-profit group, representative of all elements in the community, might instead be chartered to perform the gatekeeping function for a privately owned or government-owned system. A private cable owner might even prefer this alternative, since it would remove a time-consuming and non-remunerative burden from his shoulders.

Establishing a broadly representative non-commercial group to control cable access would not be easy, but it is an alternative well worth considering. In any event, assigning the "gatekeeping" function should be a conscious decision, not an automatic corollary to the choice of cable owner.

V. CONCLUDING REMARKS

In mapping out system design and making financial comparisons one is faced with difficult subjective judgments. Why only two cables instead of three or four? What evidence is there that the metropolitan area needs or wants an "advanced" system rather than one of more conventional limited capability? In the light of the fact that many of the services discussed above have yet to be perfected, what assurance is there that much channel space will not go unused indefinitely and constitute nothing more than a cost burden on the rest of the system?

Of course, one wants to avoid building a plant of such restricted capability that increasing demands and new services will quickly make it inadequate. Were it easy to add capacity or to retrofit as needed on an incremental basis, then the problem would be simple. But it is not easy. As mentioned earlier, the additional cost of installing a second or third cable is much lower if all cables are installed simultaneously. Or, if a one-way cable is installed but two-way services do become attractive, than the problem of retrofitting can be very difficult (for it can involve not only changing the amplifiers, but changing their spacing as well).

Yet, one must beware of constructing such excessive capacity that the prospects of using it are remote. Whether these prospects are remote or not depends on one's judgment, necessarily conjectural, about the nature of the market in five or ten years.

Where is one to draw the line? In our analysis we have attempted to delineate numerous options and to trace the consequences of alternative approaches, in order to provide a sounder basis on which the community itself can make choices. But in our illustrative examples we have gone beyond a mere enumeration of alternatives and variants to concentrate on a few cases that seem particularly interesting: Briefly stated, any cable system in the Dayton area is likely to have two cables instead of one because of the restricted capacity of a single cable without converters attached to every television set. Two cables, each with 10-12 channel capacity would cost about $6700 per mile (including tree trimming and utility pole preparation). Thus, one question relates to whether capacity should be expanded to 20 or 25 channels per cable to serve potential specialized uses. We estimate the additional cost of so doing at about $500 per cable for a total of $7700 per mile—roughly a 15 percent increase in cost for a doubling of capacity. Adding two-way to one cable would run

to another $800 or so for a total of $8500. Altogether, this package amounts to nearly a 30 percent increase in cost over the investment in one-way dual cable with lower capacity. (The additional cost for two-way capability may be of only academic importance since the FCC is proposing, in any event, to *require* it). Moreover, a third cable of 20 channels or so could be installed for another $2000 to serve the needs of, say, elementary and secondary schools as described in the *Basic Report*. Operating and maintenance costs are likely to scale roughly in proportion to these capital costs.

Thus, the basic question is whether it is worth spending an additional 30 percent for a doubling of capacity with two-way capability on the chance that new services will develop. Our own inclination is to favor the more expensive system (hence the use of this case in our basic analysis) on the following grounds: A number of cable operators are today making the judgment that this is the wise course of action. Even without FCC requirements for two-way capability several such systems (as in Akron and in Orlando, Florida) are being installed. A number of dual cable plants with high capacity amplifiers are also being constructed. Although business judgments are not infallible, still one does have more confidence in his own judgments if other groups not only are making the same judgments but are backing them with hard cash.

Second, although it is true that the new services described above would require substantial advances in terminal and in other technology, the electronics field is full of surprises. We have seen spectacular advances in the past in solid state physics and in other areas making possible applications that a few years previously could hardly have been imagined. It may turn out that some of the services described above will become economically feasible in a much shorter time then we now think possible. Others may turn out to be total duds. Yet other services, whose nature cannot now even be perceived, may become of central importance. At one extreme, even if rapid technological progress is not made, the chances are still good that an advanced metropolitan system will be economically viable on the basis of subscriber revenues alone. The addition of even modest lease channel revenues for educational applications and for pay-entertainment purposes would add substantially to profitability or to the reduction in monthly fees to other subscribers. Yet many other services may well develop over the next decade, turning broadband cable communications into a vital public utility.